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Compressed Air Magazine

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MARCH, 1923

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Industrial Use of Liquid-Oxygen Explosives
Robert G. Skerrett

Air-Driven Hoists Adaptable to All-Round Service
A. S. Taylor

Cold Storage in Modern Municipal Market
Sidney Mornington

Shooting Seaplanes from the Deck of a Speeding Ship
S. G. Roberts

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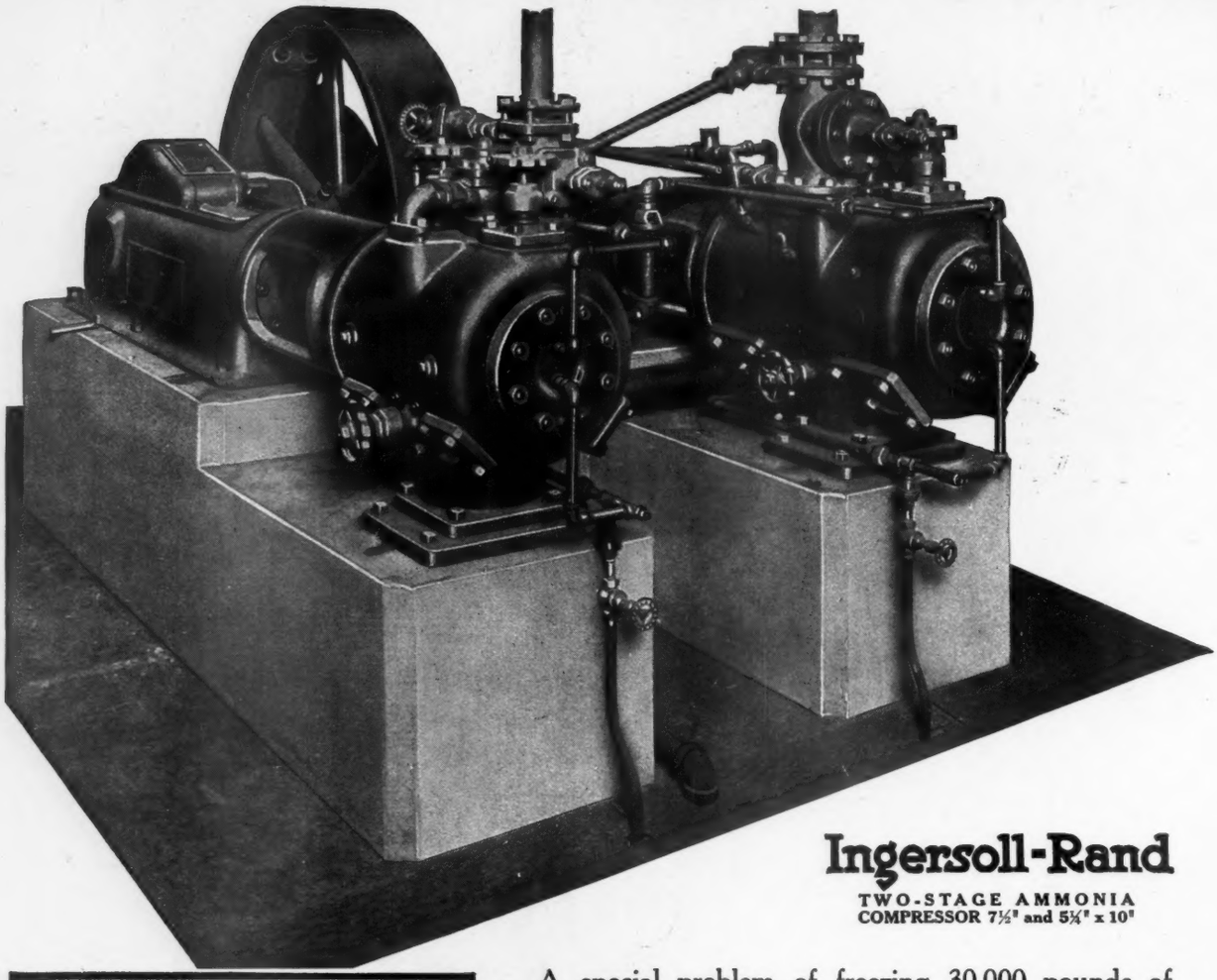

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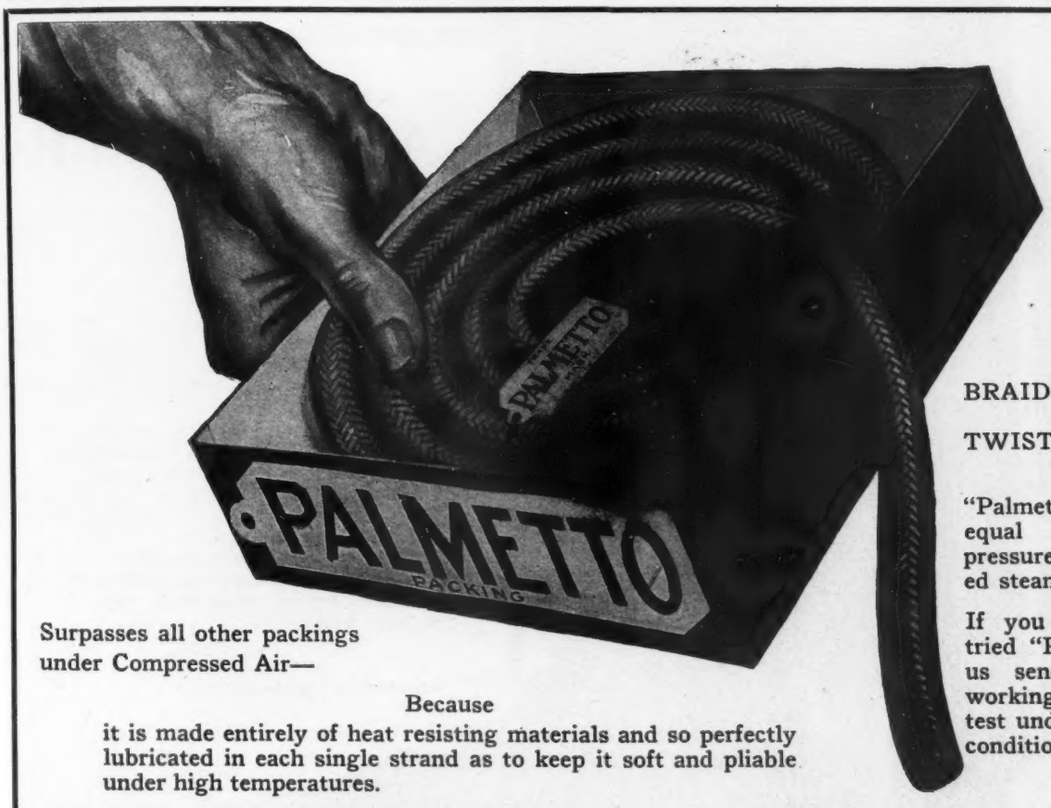

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NEW YORK · LONDON · PARIS

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BOWLING GREEN BUILDING
No 11, BROADWAY,
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VOL. XXVIII, NO. III
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Compressed Air Magazine Co.
MARCH, 1923

Industrial Use of Liquid-Oxygen Explosives

A Laboratory Will-o'-the-wisp Brought to a Stage of Practical Service

By ROBERT G. SKERRETT

INTENSE heat is always associated in the popular understanding with the firing of any of the commonly known explosives.

Instinctively, we see in the mind's eye a dazzling flash and a searing flame, and realize that the suddenly acquired expansive force of a volume of gases is capable of bursting asunder enveloping walls. The utilization, therefore, of an extremely cold liquid for blasting purposes seems, at first blush, a contradiction to the general conception of explosives which has until now prevailed. And yet liquid oxygen, so cold that polar temperatures become tropical by comparison, is today in use for blasting in mines and quarries.

Perhaps we can dispose of this physical paradox if we bear in mind that at the moment of detonation dynamite generates gases having a temperature of 5,324°F., while a liquid-oxygen explosive will produce a volume of incandescent gases having a temperature of 5,603°F. at the moment of complete combustion. Further, in reaching that temperature and the incident expansive violence, the liquid-oxygen explosive actually effects a transformation which involves a total temperature rise of 5,899.5° of heat; and it is this abrupt and great change in temperature which gives to liquid oxygen its tremendous shattering or blasting energy.

It may not be a matter of common knowledge, but the so-called smokeless, high explosives—in which nitrogen in one form or another plays an important part, are high explosives as well as relatively smokeless because of the percentage of oxygen carried by them which enables them to burn up with great speed without having to draw upon free atmospheric oxygen to promote their combustion. In other words, the chemical bond between the nitrogenous substances and the associated oxygen is so feeble that a blow, a spark, or a relatively moderate amount of heat will suffice to break the tie and to release the oxygen so that it can feed or stimulate the flame.

Such being the case, it should not be hard for us to grasp what takes place when a mass of carbon thoroughly saturated with pure oxygen, and combined with a very large percentage of it, is suitably fired. The carbon and the oxygen are instantly changed into a volume of white-hot gases capable of exerting a violent bursting effort when confined. The measure of this depending, naturally, upon the proportion of carbon and of liquid oxygen, the time required to bring about complete combustion, and the resistance momentarily offered by the container or enclosing walls. It has been demonstrated conclusively that a properly devised and detonated liquid-oxygen cartridge can do as much blasting or shattering work as any of the nitrogenous explosives commonly employed in industry.

Fascinating as the subject is, it is not our intention to even outline the various monumental accomplishments by which the road to the ultimate liquefaction of air was marked during decades of research. The story is one of scattered and, at times, disassociated achievements, of many disappointments, and, in the end, of success after years of battling with physical conditions which would have daunted most men. It is probably not an exaggeration to say that ultimate victory rested fundamentally upon a discovery made by Thomas Andrews, of Belfast, Ireland, who, in 1869, revealed that for every gas there is a particular temperature below which it can be liquefied by pressure, but above which it is impossible to induce this change. That temperature is called the critical temperature.

Prior to Andrews' disclosure, substantially every attempt to bring about the liquefaction of gases called into play the development of high pressures—some of them totaling nearly 60,000 pounds · to the square inch. While Andrews was never able to liquefy air or any of the other so-called "permanent gases," still he gave subsequent investigators a clew which brought to light in time that any gas, when at its critical temperature, could be turned into a liquid by a comparatively moderate application of pressure. To Louis-Paul Cailletet is due the honor of having first effected, in 1877, the liquefaction of air; and while his results, measured quantitatively, were meager, indeed, in the light of what Tripler did when he produced gallons of liquid air in 1893, still Cailletet's performances were of the utmost significance and suggestive value.

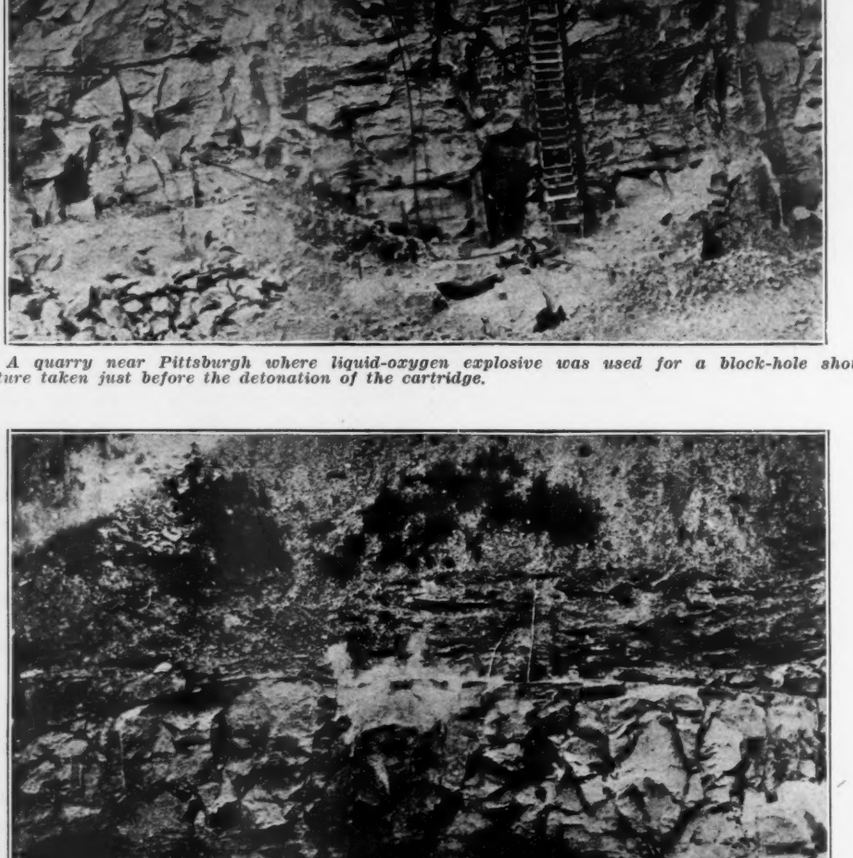
The cooling incident to a sudden drop in the pressure on the gas was what made it possible for Cailletet to liquefy air. By opening a valve, he allowed the compressed air to fall a matter of about 4,500 pounds per square inch in pressure, and this, so it was calculated, was sufficient to bring about a temperature reduction of 360°F. In short, he relied upon what has commonly become known as the Joule-Thomson

IN THE early "nineties," when Charles E. Tripler succeeded in liquefying air and in producing the stuff readily in gallon quantities, all sorts of extravagant claims were then advanced by imaginative enthusiasts; and the public was thrilled by what it was told of the many useful services to which liquid air could be put. Among these was its employment as a powerful explosive.

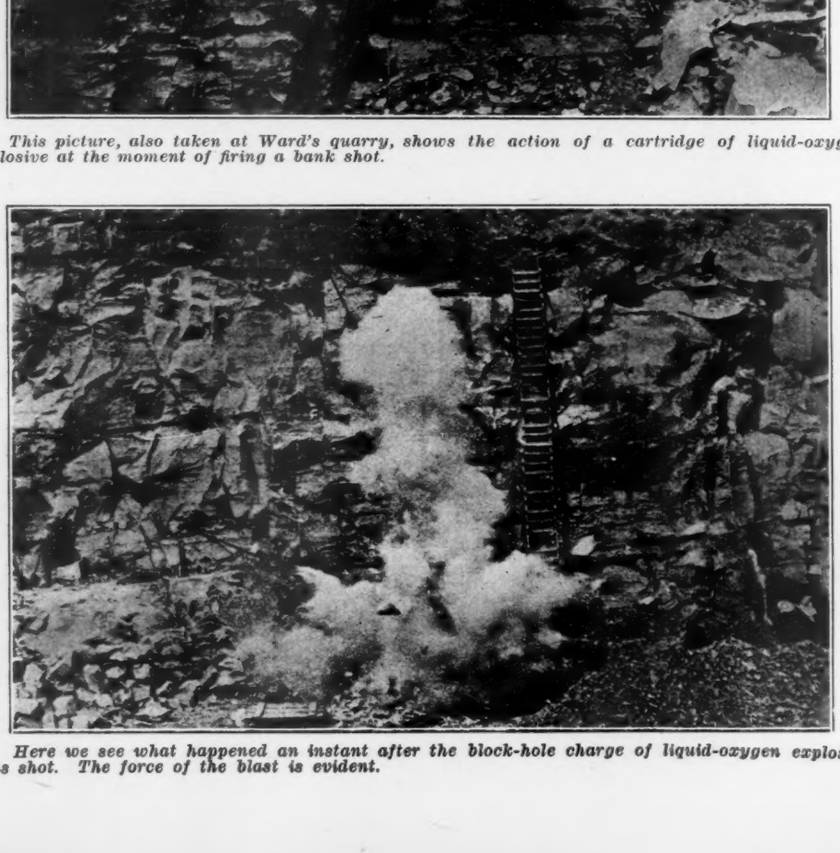
As a matter of fact, it has taken the better part of thirty years to develop from liquid air an explosive capable of competing satisfactorily with any of the well-established nitrogenous explosive compounds.

The present article deals with what has been done in this direction in manufacturing liquid oxygen and in adapting it for blasting in mines and quarries. The day of its effective and economical use in this field of service has arrived.

A quarry near Pittsburgh where liquid-oxygen explosive was used for a block-hole shot. Picture taken just before the detonation of the cartridge.



This picture, also taken at Ward's quarry, shows the action of a cartridge of liquid-oxygen explosive at the moment of firing a bank shot.



Here we see what happened an instant after the block-hole charge of liquid-oxygen explosive was shot. The force of the blast is evident.

effect; and, later on, Linde in Germany, Hampson in England, and Tripler in America utilized the refrigerating action of this phenomenon in producing liquid air on a considerable scale.

Liquid air contains 47 per cent. of oxygen—more than twice the proportion of oxygen in the normal atmosphere. A paste made of charcoal and liquid air, placed in insulating paper wrappers, was used along about 1897 for blasting in a coal mine in Upper Bavaria. The explosions were not uniform owing to the varying percentages of oxygen in the charge. However, experiments showed the way to improvement; and an explosive of this nature was employed for a time in driving the famous Simplon Tunnel. With the death of the engineer engaged in making these tests, the use of the novel explosive was stopped. Even so, enough had been revealed to show that this blasting agency might prove of practical value provided the cost of producing relatively pure liquid oxygen could be reduced to the point where its industrial application would be justified.

In seeking the foregoing goal, most of the men engaged in this line of research elected to base their work upon the throttling of the compressed air so as to obtain the fullest benefits of the Joule-Thomson effect. This meant that the pressure employed, before passing through the expansion valve or nozzle, would have to be a high one to insure a very marked drop in order to obtain the desired temperature fall upon the expansion of the gas. It is not necessary to more than point out to anyone acquainted with elementary physics that the compression of a gas calls for the expenditure of power, and power, in its last analysis, is commonly obtained by the burning of fuel or by the conversion of the energy stored in falling water. The most efficient of the air-liquefaction systems that rely upon the Joule-Thomson effect requires an operating pressure of fully 3,000 pounds. This is not economical, and leaves considerable latitude for improvement.

Now we come to the activities of Dr. Georges Claude. That eminent Frenchman, after years of indefatigable labor, invented a decidedly different type of air-liquefying apparatus; and today it is possible to obtain by his method liquid oxygen of great purity from air compressed to only 900 pounds pressure per square inch. On the face of it, the primary expenditure of power or fuel is considerably less than when the air is subjected to mechanical effort which raises the pressure to 3,000 pounds.

About 1898, Lord Rayleigh calculated that if the compressed air were made to drive a turbine, for instance, instead of being allowed merely to expand through a valve or nozzle to induce refrigeration, the ultimate chilling effect would be much greater. In other words, the air by expanding and doing work at the same time would issue from the turbine at a considerably lower temperature and, therefore, be able to promote a more rapid and a greater percentage of liquefaction—measured by the amount of power needed to compress the air in the first place. Claude, following a kindred line of reasoning, decided to interpose in the cycle of his system a simple reciprocating expansion engine to be driven by compressed air.

It is an established fact that air at a pressure of 600 pounds, if allowed to escape through a valve and to drop to a pressure of fifteen pounds, will, in doing so, experience a temperature reduction of only 18°F. If, on the other hand, the same compressed air be employed to operate a piston, thereby exerting mechanical energy, the exhaust air will be cooled to a point 225°F. lower than that of the impulse air. This, broadly stated, indicates the advance in the art of the liquefaction of gases made possible by the inventive cunning of Claude.

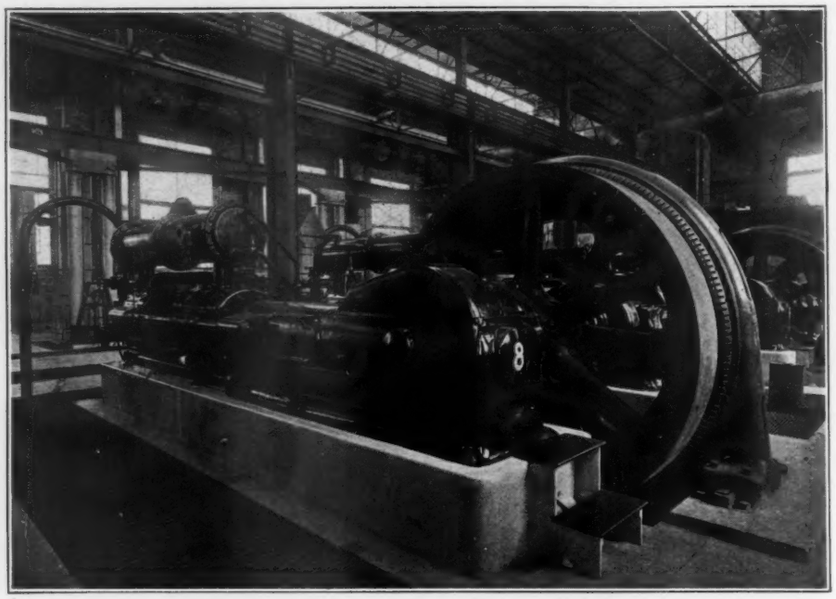
Without going into the technical refinements of a Claude liquefying unit, it will probably answer our present purpose to say that the apparatus, in addition to the indispensable air compressor, is made up of three distinctive elements. These are: two interchangers, which alternate in service as one or the other becomes clogged with frost; a compressed air engine; and a rectifying column wherein most of the liquefaction takes place and gaseous nitrogen is separated from the liquid oxygen—leaving the latter 96 per cent. or more pure, as desired. For the sake of making this subject somewhat clearer to the average reader, it might be mentioned that an interchanger is virtually a series of small tubes mounted within an enveloping tube—the small tubes conveying air from the compressor and the enclosing tube permitting a flow of cold and expanded air in the opposite direction. The outgoing cold air withdraws heat from the incoming air by radiation through the walls of the small tubes—hence the use of the term interchanger. The cold air is obtained from the engine exhaust after that expanded air has passed through the rectifying column.

The rectifying column receives the air which has been prechilled in one of the interchangers, and the air is therefore so cold that it readily liquefies when exposed to the still lower temperature which is gradually attained within the rectifying column as the operative cycle goes on. That is to say, there is a cumulative or self-intensive refrigerating action which brings the temperature of the air to 220°F. below zero, which is the temperature required to start liquefaction. It should not be difficult to understand how the liquefied oxygen is separated by fractional distillation from the nitrogen if we keep in mind that oxygen boils or vaporizes at -296.5°F. while nitrogen vaporizes at a still lower temperature, that is, -319°F. Therefore, while the liquid oxygen remains quiescent, the nitrogen tends to vaporize and to resume its normal gaseous state.

Inasmuch as the success of liquid-oxygen explosives is fundamentally dependent upon the measure of purity of the oxygen, it is self-evident why the earlier efforts to utilize liquid air, with its high percentage of liquefied nitrogen, were not infrequently unsuccessful or partway failures. Today, the best of the cartridges contain more than 70 per cent. of oxygen; and the rigid, frozen mass of carbon is, upon ignition, transformed into an intensely vigorous incandescent volume of gas within a very brief fraction of a second. This brings us to the point where we can answer the question: why should liquid-oxygen explosives be

The ballistic pendulum, at the Pittsburgh Testing Station of the United States Bureau of Mines, has revealed that a cartridge of liquid-oxygen explosive, ten minutes after soaking, has a strength in excess of that of 40 per cent. straight nitroglycerine dynamite.

A typical Claude gas-liquefying unit. In the foreground is the expansion engine; to the right, and marked with the numeral 4, is the rectifying column in which liquid oxygen is produced; immediately to the rear are two smaller columns or interchangers; and, to the left of the engine, is a rheostat connected with a small dynamo which is belt driven by the expansion engine.



The air compressor performs the first stage of the work of liquefying air from which liquid oxygen for explosive purposes is obtained. In the making of liquid oxygen large quantities of substantially pure gaseous nitrogen are secured as a by-product.

advocated for any service in preference to the well-known nitrogenous blasting mediums?

The ordinary explosives generally produce as a consequence of their combustion a considerable volume of that very deadly gas, carbon monoxide. Therefore, to guard against asphyxiation, it is the usual practice to keep the miners away from a heading where a round of shots has been fired until the atmosphere has cleared. This commonly requires between a half and three-quarters of an hour, and further work at the face is suspended in the meantime. When the men are engaged in succeeding shifts, the oncoming shift cannot take over the task until the CO, induced by the blast set off by the departing shifts has been dissipated. This interval entails a loss, especially if the miners have to be paid during their enforced idleness.

In the case of liquid-oxygen explosives, when the percentage of the oxygen is properly proportioned, all of the carbon is completely consumed, there is perfect combustion, and the residual gas is comparatively harmless carbon dioxide. In fact, in Europe, where liquid-oxygen explosives have been employed in industry for a number of years, it is generally the practice for the miners to return to the heading or face of the working almost immediately after a round is fired. There is no record of any ill effects from this procedure. The time—and the money-saving advantages of this are obvious. It should be evident that there is also involved a factor of safety of considerable moment.

The safety of mining is undoubtedly increased under some conditions by the substitution of liquid-oxygen explosives. For example, the United States Bureau of Mines has thus emphasized their virtues: No danger in transportation of the explosives to the point of use; practically no danger of premature ignition; the danger of a misfire, in the event a cartridge is not promptly exploded, is eliminated by waiting 30 or 40 minutes after lighting the fuse—this interval sufficing to allow for the evaporation of substantially all of the oxygen; an unexploded stick of dynamite is always a menace if encountered while mucking or during the removal of coal or ore from a mine—the liquid-oxygen cartridge, under similar conditions, is "dead;" and, finally, liquid oxygen can be held in storage and does not become an explosive until combined with the carbonaceous cartridge. The latter union does not take place until a few minutes before inserting the cartridge in the drill hole.

More than two years ago, some of our government experts reported that there were in service in continental Europe nearly 140 liquid-oxygen plants capable of turning out hourly a total of 3,797 liters. Assuming that many of those plants were for stand-by purposes, and that the amount of utilized liquid oxygen did not exceed 900 liters an hour for nine hours daily throughout a working year of 300 days, then the measure of liquid oxygen employed amounted to substantially 5,350,000 pounds in the course of a twelvemonth. It was declared that this quantity of liquid-oxygen explosives was, in effect, equivalent to about 8,000,000 pounds of dynamite.

It may be of interest to mention that one company in Lorraine, France, is mining its entire annual output of 1,500,000 tons of iron ore by the use of liquid-oxygen explosives; and it is authoritatively declared that fully 80 per cent. of the iron ore mined in that country today is being blasted out by means of this new agency.

The employment of liquid-oxygen explosives on an industrial scale in the Western Hemisphere was initiated in 1921 at Pachuca, Mexico, where are located some of the richest silver mines on this continent. At that point there are recovered by refining quite 60 tons of silver monthly. The results obtained by the adoption of liquid-oxygen explosives have been very gratifying, and confirm all that has been said in their favor.

The first application of liquid-oxygen explosives in the United States on a practical, industrial scale will shortly be made at the great iron-ore mines of the Witherbee-Sherman Company, Mineville, N. Y., near Lake Champlain. These mines are capable of producing 1,500 tons of ore daily. The liquid-oxygen plant, which will have an hourly output of 75 liters, will be placed down in the mines at a depth of nearly 1,000 feet below the surface level. The object of locating the plant there is to avoid carrying the explosive down through the single great shaft which constitutes the busy route for the incoming operatives and the outgoing miners and ore. The subterranean position will also facilitate the speedy distribution of the liquid oxygen to the numerous headings.

Liquid-oxygen explosives have come to stay; and their adoption will, undoubtedly, be rapid in those fields of mining, quarrying, and excavational work wherever conditions permit.

NOTE:—Articles dealing with liquid-oxygen explosives appeared in the June and the November issues of COMPRESSED AIR MAGAZINE during 1921.

URGENT NEED IN INDUSTRY OF CONSERVING EYESIGHT

DISCLOSURES made by the Hoover Committee on the Elimination of Waste in Industry showed that poor eyesight among workers was causing heavy annual economic losses. Surveys in numerous cities have revealed similar conditions of vision in the schools.

To remedy this situation is a national duty, Secretary James J. Davis declares in a statement made public by the Council. "In my earlier life, as a workman, and in the course of my duties as Secretary of Labor," he says, "I have come to know something of this problem, particularly in its relation to men and women in industry. It is a problem in human service which, in its solution, will mean much to the whole service of America in life, economic prosperity, and happiness.

"Sight is, paradoxically enough, the most highly prized and at the same time the most abused of the human senses. I am informed that of the 40,000,000 or more men and women who are gainfully employed in the United States, upwards of 25,000,000 suffer from some form of defective vision which is capable of correction, and which should be corrected. This is an astounding number, and its reduction to a minimum would plainly better the condition of these sufferers, increase their efficiency in industry, and generally benefit the nation."

The Board of Health of Lower Austria is urging the passage of a law to prohibit the use of automobiles on Sundays on the ground that "the dust raised by the cars, especially in the open country, is harmful to the lungs of children and causes tuberculosis." The root of the evil in this case is not the automobile but the poor condition of the roads, which have been neglected since 1914.

Growing To Keep Pace With A Growing Industry

The 1923 Good Roads Show in Chicago Established Records in the Number of Exhibits and in the Volume of Attendance. New Portable Compressor, Mounted on Ford Truck, Part of Novel Display

NO BETTER summing up of the 1923 Good Roads Show has been heard than that voiced by the perspiring man who, after a complete tour of the exhibits, stopped and gasped: "Well, road building is no longer just a pick-and-shovel job—this machinery proves it; and the best part of it all is that a fellow can see the whole works and make his choice right here!"

That that fervid booster was right was amply proved by the facts and figures. There were more than 200 exhibits, and the registered visitors exceeded 6,500. The show was a gripping climax to a tremendous, concentrated effort on the part of the American Road Builders' Association and the manufacturers of good roads machinery.

The most modern road-building equipment and labor-saving devices were in evidence. There were backfillers, clamshell buckets, cableways, industrial cars and track, conveyers, locomotive cranes, crushers, graders, mixers, locomotives, pavers, plows, scrapers, rollers; steam, electric, and gasoline shovels; sprinklers, sweepers, a variety of tractors, wagon loaders and unloaders, motor trucks and special bodies, paving and surfacing materials, etc., etc. The exhibits of several state highway departments and the extensive and wonderfully planned display of the United States Bureau of Public Roads all added to the educational value of the show, and made it plain that our local and national experts thoroughly believe in and support the work.

One noticeable advance over the 1922 show—a feature which will interest the readers of COMPRESSED AIR MAGAZINE—was the markedly increased part played by the products of the manufacturers of pneumatic machinery. Six companies exhibited air compressors; and all of those displayed were of portable types mounted on wheels. This was due, no doubt, to the steadily widening favor which compressors of this sort are winning among road builders. Several of the larger manufacturers also displayed air-driven tools for the drilling of rock, for the cutting of pavements, for the digging of soil, and for other services. In fact, the Ingersoll-Rand Company, in order to make its exhibit outstandingly convincing, made a point of showing its machines in actual operation.

Every hour or so, the hall would echo with the rapid blows of a "Jackhamer" drilling into a block of granite, or there would be heard the less noisy action of a clay digger cutting out stiff clay upon which an old-type spade would not make a mark. In short, the skeptical could see for themselves and even run the tools if they so desired; and this served on many occasions to dispel any lurking doubt regarding speed records and the performances claimed for the equipment.

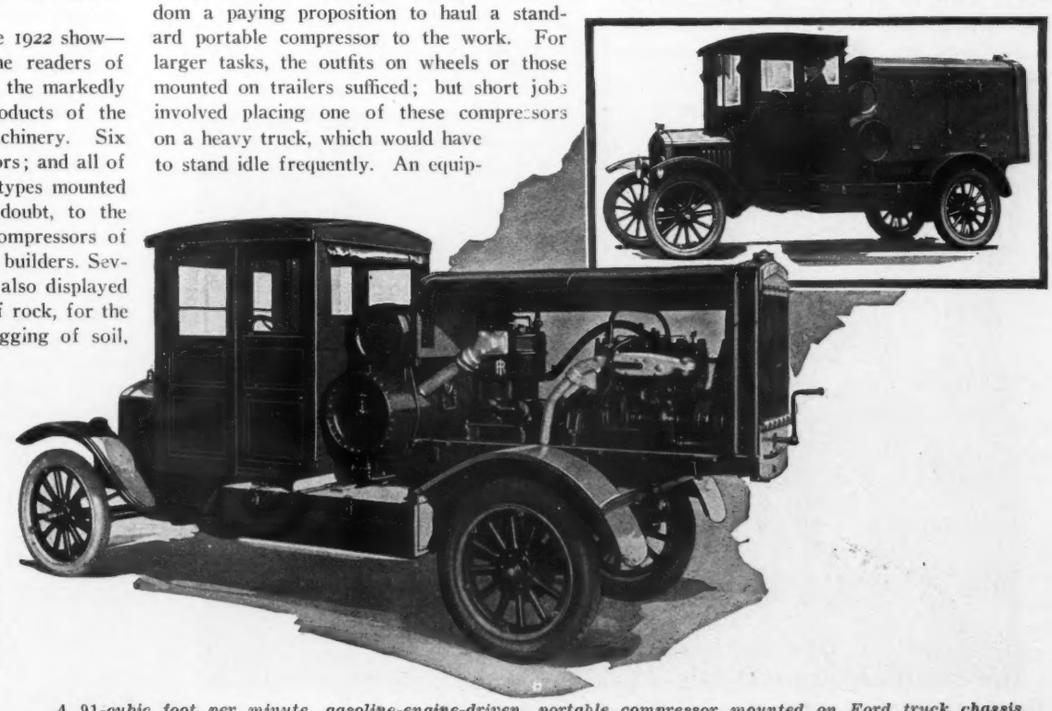
The past few years have witnessed the development of a large number of new or special pneumatic tools for highway work; and many of the visitors saw for the first time striking proof of what has been done to advance the art of "compressed air for the road builder."

The road-building fraternity has generally adopted the portable unit using a vertical, duplex compressor driven by a 4-cylinder, 4-cycle tractor type of gasoline engine—a type originally developed by the Ingersoll-Rand Company. Nearly every year of the past decade has disclosed improvements in the initial design—both as to mechanical refinements and range of sizes. The past twelvemonth has contributed the new Type Twenty machines of 91 and 160 cubic feet per minute capacities, not to mention the 210-cubic foot size compressor.

In January gone, the foregoing manufacturer exhibited and operated a unique air compressor outfit mounted on a Ford chassis, which aroused much interest and provoked a deal of admiring comment. Until the appearance of this unit, there was no portable air compressor which could "stand the gaff" of high-speed transportation. Small jobs, requiring anywhere from ten minutes to a day's time, were often necessarily performed by hand because it was seldom a paying proposition to haul a standard portable compressor to the work. For larger tasks, the outfits on wheels or those mounted on trailers sufficed; but short jobs involved placing one of these compressors on a heavy truck, which would have to stand idle frequently. An equipment of this sort is expensive to run and to maintain.

The value of a smaller unit—one of sufficient capacity to operate a single "Jackhamer" rock drill, or two paving breakers, or several riveting or chipping hammers—should be appreciated, and so it was. Take, for example, the tearing up of paving during manhole repairs or the digging of a small section of trench in making pipe-line repairs. Work of this sort ought to be done with all practicable dispatch; and while this is in hand at one place service of a similar sort may be required in another section of the city, perhaps five or ten miles away. With an outfit like the Ford portable it is necessary only to crank up, to tell the operators to hop aboard, and to be off to the other job as fast as the law allows.

The complete, portable air compressor plant is built in a way to facilitate its mounting on a standard Ford chassis with a minimum of assembly work. The compressor is supported by a steel base, and the outfit is covered by means of a sheet-steel canopy having removable, steel doors. In securing the compressor on the truck chassis it is not needful to drill holes in the frame or to alter the latter in any way. The plant consists of a 2-cylinder, vertical compressor of 91 cubic feet per minute capacity, direct-connected to a 4-cylinder, 4-cycle, tractor type of gasoline engine, of a radiator and fan for cooling the water for the compressor and the engine, of an air receiver, of a fuel



A 91-cubic foot per minute, gasoline-engine-driven, portable compressor mounted on Ford truck chassis. Note the compact arrangement, and the steel covers protecting the outfit when in transit.

A complete operating exhibit displaying portable compressors and air tools used by progressive roadbuilders.

tank, and of other essential accessories. There are also supplied several tool boxes which are attached to the steel compressor frame. These are used to hold the rock drills, paving breakers, or other pneumatic tools. One of the accompanying illustrations shows the simplicity of the get-up of this outfit. Light, sheet-steel doors completely enclose the compressor plant when in transit or while idle, thus protecting it from the weather or from unauthorized entry when not in use.

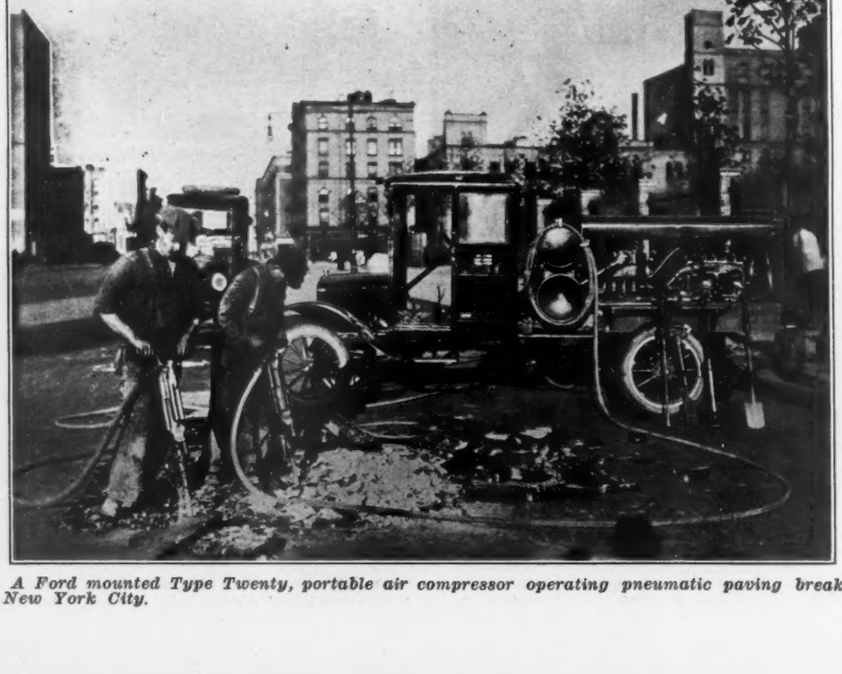
A generally similar equipment is provided for electric motor drive. An arrangement of this character is found to appeal strongly to those electric light and railway companies that have standardized current conditions.

It may be of interest to our readers to learn that it is the intention of the Canadian Good Roads Association to hold a show next June at Hamilton, Ont., at the time of the annual convention there.

COOL AIR IN THE BAKERY

IN the big bread bakeries, where the dough is mixed in batches of from a quarter to half a ton, the control of the temperature is of great importance. The flour and the yeast are mixed with cold water; but the friction of the beating arms soon raises the temperature. To let it go above 70° F. affects the ultimate taste of the bread. To prevent the rise, a constant supply of air, cooled to 40 or 45 degrees, is fed into the mixer while it is operating.

This is a simple story, but it is not all of it. The air must be pure, and so it is washed or filtered. Besides that, it must not be too dry, consequently its temperature must not be too low. The cooler it is the less moisture it will carry; and a larger volume of air at 45 or 50 degrees will convey considerably more moisture than a smaller volume at 40 degrees, although the latter might have a quicker cooling effect.



A Ford mounted Type Twenty, portable air compressor operating pneumatic paving breakers in New York City.

SHANDAKEN TUNNEL BORED FROM END TO END

AT THREE O'CLOCK in the morning, February 13, the remaining rock barrier in the Shandaken Tunnel, piercing the Catskill Mountains, was broken through, bringing to a successful conclusion that phase of the work on the longest tunnel in the world. This 18-mile bore, which was begun early in 1918, forms a link in the water supply system of Greater New York; and when the rainfall is normal it will carry daily a flood of 600,000,000 gallons of water from the Schoharie reservoir into Esopus Creek, and thence into the Ashokan reservoir.

The average depth of the tunnel below surface level ranges from 255 to 647 feet, although at one point the line lies 2,200 feet beneath a towering peak. From end to end, this water main, which is horseshoe shaped in cross-section, has an internal height of 11½ feet and a width of ten feet three inches. Tunneling was steadily pushed from a number of headings, where pneumatic rock drills were employed to work their way through the intervening barriers. So satisfactorily have the air-driven tools done their part of the job that the Shandaken Tunnel will very likely be completed well within the specified contract time of 6½ years.

SUCCESS OF AIR PREHEATERS

IN a recent issue of *Rock Products*, we find an interesting account of the use of preheaters for the compressed air used in operating the drills in the Millard quarries near Lebanon, Pa. When first installed, the drills did not prove satisfactory as they failed to drill up to rated capacity. Machines of another make were employed with no better results.

Then a preheater was tried made of a common upright coal stove about which was coiled a length of 2-inch pipe, through which the air was carried. The difference in the operation of the drill was quite noticeable; it drilled more rapidly, and with no increase in air consumption. Since then the company has had especially designed stoves built and is applying them to each of its drills.

The article referred to gives the preheater credit for increasing the pressure of the air at the drill, which is not quite the correct way to state it. The heating of the air increased the volume of it and that may have given the compressor a chance to maintain a higher pressure with the same free air consumption. The heating of the air also prevented the freezing or the approximate freezing of the drill exhaust, which would have much to do with making the pneumatic tool work better.

The United States Forest Service is experimenting with carrier pigeons as aids in fire fighting. The home of the pigeons is at the central headquarters, and they are distributed from there to the various stations. In a recent test, a pigeon was released from the scene of a fire; but before a relief party could be organized at headquarters a second pigeon arrived with the report that the fire was under control.

Cold Storage Service in a Modern Municipal Market

Manufactured Ice and Refrigerated Rooms Now Essential to the Proper Handling and Preservation of Fresh Foodstuffs

By SIDNEY MORNINGTON

THE BOON of cold storage is probably in nowise more strikingly evidenced than in its relation to the food supply of a large municipality.

In every up-to-date city market the preservative service of artificially maintained low temperature is brought home to the citizenry of all walks of life. The tables of the well-to-do, of those of moderate means, and also of persons of really slender resources reflect in one way or another and in varying degrees the present-day contributions to the pleasure, the comfort, and the welfare of the community, which are made possible only by the agency of mechanical refrigeration.

For 30-odd years the Reading Terminal Market has been a feature of Philadelphia's communal life, but it is highly likely that scarcely more than a small percentage of the thousands who benefit by that institution have any knowledge of how the counters and the stalls are kept continually laden with their diversified and appetizing commodities. It should be self-evident even to the casual observer that the meats, the fish, the fruits, and the vegetables of many varieties cover the whole range of perishability; and it should be equally obvious that care is necessary to keep these foodstuffs within definite temperature limits lest they become warm and spoil quickly.

The Reading Terminal Market is the biggest thing of its kind under one roof in the world and accommodates 900 stands. It is interesting to recall that this establishment is the survival of a municipal market that was located close by for a long while. As a matter of fact, Market Street, only a short block away and now one of the city's most bustling business thoroughfares, got its name originally from the practice of the outlying farmers who used to bring their produce into town and peddle their wares along the sides of this roadway. In those early days, the thrifty husbandmen carried their commodities in wagons or in bulging saddlebags, and the townspeople were of necessity supplied by those tillers of the soil that lived a comparatively few miles distant. The dietary was, therefore, rather a limited one and subjected to very marked seasonal differences even though it was abundant judged by the standards of the period. Contrast that situation with what the market now offers, thanks to the service of cold storage.

Today, fish, crustaceans, and bivalves, taken from the Atlantic Ocean from Maine to the Gulf of Mexico, caught in the Great Lakes and other inland bodies of our domestic waters, and some even from far-away Alaska, are to be had the year through in the Reading Terminal Market. Similarly, the fruits and vegetables of the entire continent are there displayed in season and out of season—gaged by local climatic circumstances. Indeed, to be exact, fresh fruits and certain vegetables from alien lands are likewise offered to tempt the purchaser and to stimulate the appetite. From the remote range, both at home and abroad, are obtained nourishing beef, veal, mutton, lamb, pork, etc.; while distant dairies and poultry farms add their distinctive share to the diversified aggregation of edibles.

GOOD FOOD, and an abundance of it, is one of the material blessings about which Philadelphians have been rather fussy for many decades.

The City of Brotherly Love has, from its earliest days, had reason to boast of its public markets, where the bounty of the outlying agricultural counties could be had in season as well as the products of the fishing industry operating upon the neighboring or comparatively near-by waters.

In the course of its growth, Philadelphia, like the rest of our large municipalities, has had to go farther and farther afield for its edibles; and the ever-mounting standard of living has come to demand many naturally perishable foodstuffs out of season. How the modern and somewhat indulged palate is satisfied is the reason for being of the accompanying article.

The preservation of the foregoing foodstuffs until they can be disposed of profitably is not accomplished by merely putting the goods away over night in conventional ice boxes but by placing them, instead, in large and suitably chilled chambers which constitute the units of the cold-storage catacombs situated below the street level and directly beneath the market space familiar to the public. This whole system of underground vaults for the holding of perishable wares would be impracticable if dependence were placed on the availability of enough natural ice to provide the needful measure of cooling effect.

Some idea of the spaciousness of the cold-storage rooms can be had when we are reminded that these numerous compartments have an aggregate storage capacity of fully 1,000,000 cubic feet—the equivalent of a single rectilinear vault dimensioned 100 feet each way. The temperature in each chamber is regulated so as to meet the requirements of the particular goods held there; and this may run all the way from close to zero to the freezing point or a little above it. The object, of course, is to arrest chemical changes or microörganic activities which might otherwise lead to decay or injury. There was a time when the frosting or freezing of living matter was supposed to mean its ruin, and yet, as we shall see presently, man-made winter may both retard disintegration or decay and even be needful to the ultimate development and blossoming of certain plants.

Inasmuch as this article is to describe the various departments of the Reading Terminal Market & Cold Storage Company's establishment, it would probably be best for us now to start with the refrigerating machinery and the ice-making end of the enterprise. The latter phase of the plant was installed a year or so after the market was built—that is to say, about 1894, and the distilled-water system, then commonly in vogue, was adopted. This method of manufacturing ice is still employed; and most of the water used for this purpose is obtained by condensing the exhaust steam from auxiliaries which form part of the plant outfit. However, live steam, direct from the boiler, is drawn upon to supplement the exhaust steam in furnishing all of the water needed when the ice tank is operating to capacity.

Following the usual procedure, the hot water, upon leaving the condenser, goes to a reboiler where live steam is fed to the heating coil. From the reboiler the water is piped to a skimmer; from the skimmer it goes through coils which are cooled by water from the city mains; thence to a charcoal filter; and from the latter it is discharged into any one of three storage reservoirs, each of which is capable of holding between 400 and 500 gallons.

The ice tank has a capacity of 30 tons; and the practice is to pull about 200 cakes daily—each of 300 pounds. In the wintertime, however, the output averages 25 tons every 24 hours. The ice plant was installed because the market men, during the first year or two of operation, were obliged to buy their ice outside and to pay $10 a ton for it. This was not considered good business; and as the Philadelphia & Reading Railroad, which is interested in the Reading Terminal Market & Cold Storage Company, also wanted large quantities of ice, it was decided to provide an ice-making equipment. Since then, the plant has furnished enough ice to meet the needs of the stalls, to ice all of the railroad's passenger cars at the train shed, and to provide ice for the line's outlying stations as far up the road as Norristown, approximately twenty miles away.

While the ice-making equipment is run virtually at capacity the year through, during the

One of the many meat stalls in the Reading Terminal Market.

late fall, the winter, and the first of the spring anywhere from 50 to 75 per cent. of the ice manufactured is put away in storage, and space for this purpose is available for the accommodation of 7,500 cakes. It is this reserve that supplements the current capacity of the plant and makes it possible for the company to meet all demands both of the market and of the railroad throughout the other months of the year. Mr. George H. McKay, who has been the administrative head of the enterprise since its inception, tells a rather amusing story regarding its ice-storage feature.

"After we had been going along swimmingly for some years, a rival ice concern approached the president of the Philadelphia & Reading Railroad and offered to sell the line, at an attractive price, all the ice it might need for the water-coolers in the passenger cars and for outlying stations; and our competitor took pains to point out that our ice tank could not turn out enough ice daily to satisfy the requirements of the market and of the railroad in the summer season. The president promptly sent for me, explained the situation, and was disposed to accept the proposal. I told him that our competitor was right in part, but that our ice storeroom had been saving the day for us and would continue to do so unless the call for ice were considerably greater than it had been. The president seemed satisfied and I went away believing the matter settled.

"Our rival persisted, and retorted by declaring that even if we could put away ice during the cool or cold months still the cakes of ice would freeze into one solid mass and would have to be virtually quarried out to make it available—an operation which would add substantially to the ultimate cost of the commodity. I knew that the quickest way to convince the president as well as the representative of the other people would be to take them right into our ice room. When I got them there I had my men shift blocks of ice from different points and made it perfectly plain—contrary to the contention that ice cakes could not be stored without freezing together—that they could be placed in contact with one another and remain separate pieces. Failure previously to accomplish this elsewhere was due to the faulty practice of permitting the temperature in the storage chamber to rise to 32° F. or slightly above it. This inevitably led to superficial melting and to the freezing of the blocks into a single great body of ice. My success was the result of seeing to it that the temperature in the room was kept about 4° below the freezing point."

When the ice tank was built, the plant had a vertical, single-stage, steam-driven, Frick ammonia compressor of 100 tons refrigerating capacity. Afterwards, two electrically driven, Frick ammonia compressors, each of 100 tons capacity, were added to provide the necessary refrigerating service for the increasing number of cold-storage compartments and for the ice-making end of the business. The steam unit is now virtually a stand-by or reserve machine which is used infrequently. Until within the past year the cold-storage chambers have been generally chilled by calcium chloride circulating through suitable coils in each of the compartments—the calcium chloride solution for this service being lowered to the desired temperature by passing it through a shell cooler.

About a year ago, the management of the market decided to amplify the existing facilities

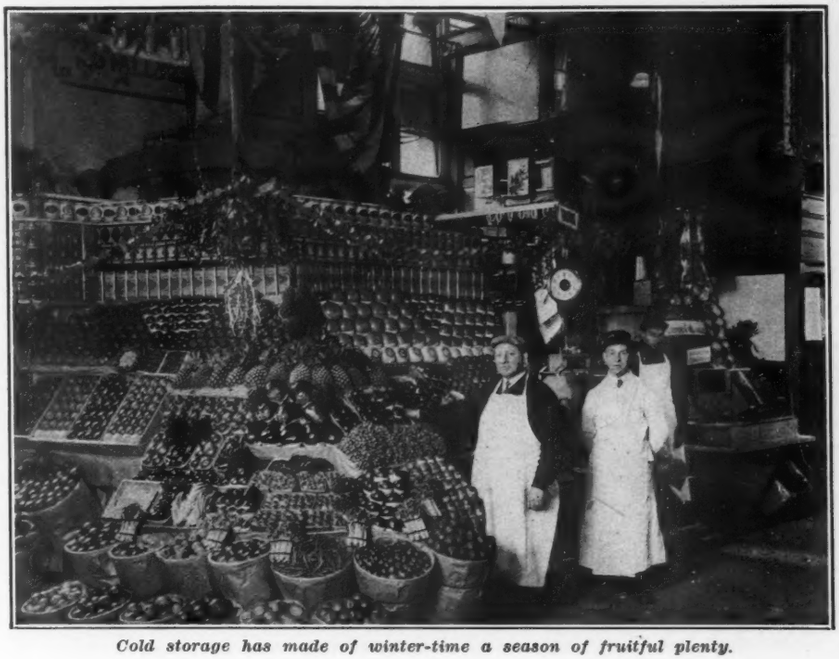
This cold-storage room contains many barrels of cold-pack fruit of various kinds.

Looking into a meat cooler filled with scores of sides of beef.

by creating two large freezer rooms in the basement. Accordingly, these were formed with a height of ten feet, a width of 25 feet, and a length of 50 feet. The object of this improvement was to furnish space especially for the handling of large incoming shipments of poultry. As is well known, Philadelphia poultry has long enjoyed a reputation for excellence, and one prime factor in the successful holding and handling of foodstuffs of this sort is prompt and rapid freezing before there is any chance for the goods to become warm enough to start harmful chemical changes in the flesh.

In order that these rooms could make the most efficient use of the refrigerating agency, it was necessary to thoroughly insulate all of the walls as well as the ceilings and the floors; and to this end the concrete walls, etc., carry two layers each of 4-inch cork board. It should be remembered that cold otherwise would escape by radiation into the ground and into the outlying atmosphere or body of the building. Indeed, during the excavating for certain improvements and repairs, it was found that the frost produced artificially reached into the underlying earth to a depth of four feet! That represented wastage, which meant the expenditure of just so much more fuel or unproductive electric current, and occurred beneath cold-storage rooms where the temperature probably never dropped much if any below 15° F. For sharp freezing, on the other hand, the temperature may be around zero or even lower—depending upon the nature of the commodity to be treated, the volume of it, and the need of rapidly freezing it through and through.

To take care of the two freezers, the Reading Terminal Cold Storage & Market Company bought and installed a 2-stage, electrically driven, Ingersoll-Rand ammonia compressor, type "XCB", 7½ and 5½x10 inches, having a refrigerating capacity of 30 tons. This machine is capable of lowering the temperature in the freezers to 28 degrees below zero, as has been established by conclusive tests. Each of these rooms is equipped with three independent refrigerating coils, and one or more of them is brought into service agreeably to the requirements of the moment. The coils are chilled by the direct expansion of the gaseous ammonia within them. Circulating brine is not employed in these compartments.



Cold storage has made of winter-time a season of fruitful plenty.

Perhaps it might be of interest to the reader to have explained just what 2-stage compression means. A machine of the sort under consideration is virtually a combination of two single-stage units joined together by a connecting pipe. The larger or low-pressure cylinder draws in the gaseous ammonia from the line at a pressure, let us say, of from five to twenty pounds, and discharges the gas after it has been compressed to a pressure of from 65 to 75 pounds to the square inch. It is at this pressure that the gas enters the smaller or high pressure cylinder from which it is expelled at a pressure of 185 pounds to the square inch. This highly compressed gaseous ammonia is liquefied in a condenser, and it is the subsequent vaporization of this liquid ammonia which chills the coils in the freezer rooms as the expanding gas greedily absorbs heat from the surrounding atmosphere. Thus, the tempera-

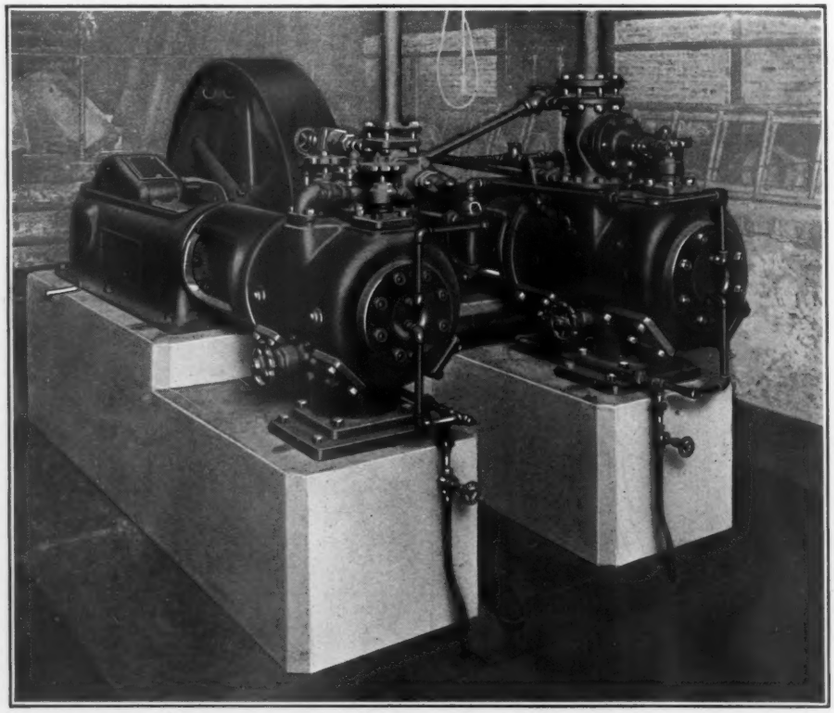
The cans are placed in the ice tank and are charged with distilled water by an automatic filler.

In the tank-room of the ice-making plant. The two cans under the hoist hold cakes of ice.

Another cold-storage chamber holding crates and boxes of fresh fruit, cans of scallops, and barrels of other perishable foodstuffs.

ture of the air, as well as the temperature of the goods in cold storage, is lowered to the desired degree.

The 2-stage compression of ammonia gas has a number of outstanding advantages over single-stage compression. The improved machine, as typified by the latest addition to the plant in question, is equally adaptable to either ice-making or cold-storage work. Indeed, during warm weather, this compressor will serve not only to refrigerate the freezer rooms but to augment the capacity of the entire system. It should be mentioned here that the valving employed in this compressor is recognized as a distinct advance in the art; and the plate valves used are so designed that they will wear for a long while, insure tightness at all times, and yet act quickly, positively, and automatically at the high speeds now demanded for compressors that are driven either by belt or by direct-connected motors. The compressor is equipped with a unique feature in the form of a series of so-called "clearance pockets," which make it possible to alter the clearance space and thus to modify the load while still running at a constant speed. By this means it is practicable to cut down the capacity of the machine to 75 or 50 per cent. of the full load capacity output—reducing accordingly the consumption of electricity. The several characteristics enumerated make for increased efficiency and operative economy.



The 10-inch stroke, "Ingersoll-Rand" type, 2-stage, belt-driven, ammonia compressor which takes care of the two big freezer rooms at the Reading Terminal Market, Philadelphia, Pa.

The day the storerooms were visited by the writer, one of the freezers held poultry, sweetbreads, turkeys, and frozen eggs—the latter being part of a shipment from Vladivostok; and at that time the temperature was about 12° above zero. Generally speaking the temperatures throughout the different cold-storage spaces range from 5° to 38° above zero to suit the needs of different commodities, while the "coolers" are kept at or just below the freezing point. In the coolers are put fresh meats.

It has probably puzzled a good many of us how confectioners, ice-cream manufacturers, soda fountains, etc., are able to provide seemingly fresh fruits for their products both in and out of season. The secret was made clear by the contents of some of the chambers of the cold-storage labyrinth beneath the Reading Terminal Market. To those unfamiliar with cold-pack fruit, let it be said that strawberries, raspberries, cherries, peaches, etc., can be preserved by combining them with sugar and putting them away where the temperature can be maintained low enough to avoid the initial stages of fermentation. No cooking is necessary. The temperature in the rooms, where barrels filled with these commodities were placed, was around 16° F.

It is not possible within the space available here to do more than mention briefly some of the many things tucked away in the basement of the Reading Terminal Market. There were apples from New York, Washington, and Missouri; citrus fruit from California and Florida; grapes from South Africa, Spain, and the shores of the Mediterranean, and other fruits from South and Central America and the West Indies. Oysters from the Chesapeake and more northern waters. Ferns and decorative leaves from the South; lily bulbs from Japan; and "valley pips" from near by. The latter are the source of the lilies-of-the-valley without which no bridal bouquet is complete. These roots or nodules must be given the frosty nip of winter to make them bloom; and when this is done artificially the florist can bring them to flower by a few weeks of forcing under glass. Lacking this touch of freezing cold, plants can be grown from the pips but they will not bear the lovely, wished-for stalks of snowy bells.

While much more could be said about the Reading Terminal Market & Cold Storage Company's activities, this summary will probably serve to give a fairly comprehensive idea of the scope of its operations and the part played by that concern as an indispensable Philadelphia public utility. Profiting by the excellent performances of the 2-stage compressor at the Arch Street station, the railroad, which is also interested in the Reading Cold Storage & Ice Company, is going to install three direct-connected, electrically driven machines of a similar character and make in the plant at Reading, Pa., which is about to undergo enlargement.

Drill Steel and the Drill Steel Sharpener

PART II

By FRANK BLACKWELL

IN THE preceding installment of this serial an effort was made to describe how drill steels should be handled to make them fit for their work in the first place and subsequently, when returned to the blacksmith shop, from time to time, to restore them to serviceable condition. The author urged, as will be recalled, that the blacksmith should occasionally go underground to see his drills in use so that he might have a better grasp of what is expected of them and how best to correct their imperfections.

In the present issue, the aim will be to bring out what are the consequences of employing poor drill steel in underground operations. The results attendant upon the use of faulty drill steel and the consequent loss of time to the miner have not in the past been fully realized; nor has the importance of properly formed, correctly gaged and tempered drills been given, in many cases, due consideration. Let us point out now the defects of drill steel, and, likewise, discuss each in its relation to the time wasted at the working face.

The loss of five or ten minutes here and there on a machine in getting a drill to the bottom of a bore hole seems, in itself, a small matter, but this loss, when multiplied by twenty or 30 machines four or five times per shift, amounts to real dollars and cents. Drilling delays occur in everyday practice and are taken as a matter of course, or they are charged up to the overall drilling time. They are considered unavoidable evils connected with drilling and drill machines. Such, however, is not the case. Stuck and binding steels, certain repairs to drills, and the changing of machines, are all in the preventable class of delays. They are certainly unnecessary, and their causes can be absolutely traced to drill steel.

The causes for delays at the working face are: Improper gaging of bits; improper tempering; poorly shaped bits; shanks too long; shanks too short; rough edges on hole in steel for water tube; imperfect shank ends.

In connection with the improper gaging of bits, let us assume that a batch of steel comes into the mine which is supposedly gaged in the following manner:

2-foot	drills—	1⅞	inches
3 "	"	1¾	"
4 "	"	1⅝	"
5 "	"	1½	"
6 "	"	1⅜	"

On using calipers, we find that some of the 3-foot lengths are 1 13/16 inches and some are 1 11/16 inches. This condition, we will say, exists throughout the entire lot,—drill bits, in some cases, being 1/16 inch under or over size. The runs and gages have been determined by previous tests and experience, using perfect bits, and we find the 1-foot run and the ⅛-inch drop in gage to be correct for the work at hand. We run a 2-foot steel out to its required depth, and the gage is worn not quite ⅛ inch. The 3-foot steel with a 1¾-inch bit should follow with no reaming, but, instead, we put in a 3-foot steel of 1 13/16 inches. This steel sticks and binds and goes only to within six inches of the bottom of the hole. The miner tries to turn the steel with a pipe wrench, but the machine has driven it tight and it cannot be freed with the wrench. The next thing in order, then, is to pound the steel with a chuck wrench, axe, drill steel, or hammer. The jarring loosens the bit a trifle at each blow; and, if the ground is rather hard, five or ten minutes of pounding will get the steel to the bottom of the hole. After this grinding and reaming on the side of the hole the gage is worn below the working limits (bits lose gage faster this way than in actual free drilling) or, perhaps, the corners are chipped off. In either case, the gage of the hole is smaller than the gage of the steel, and in order to follow with the rest of the steels the same pounding and hammering is necessary with each gage.

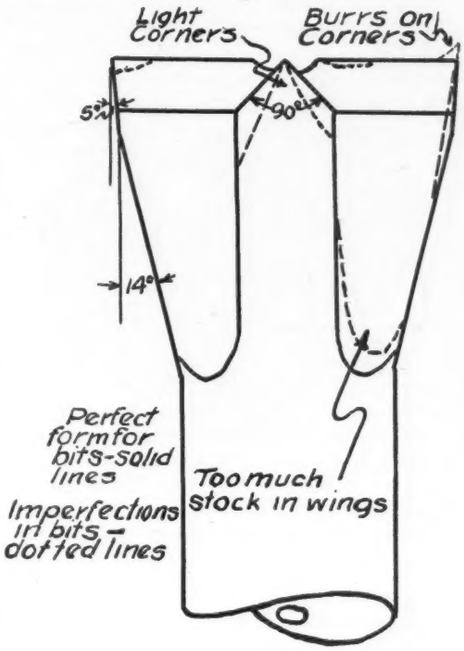


Fig. 8

Following upon badly worn gages come badly fitchering holes, which add to the troubles. It is not uncommon with poorly gaged bits to spend 50 per cent. of the time pounding the steel. Further, when a hole is going bad, and much pounding and wrenching are necessary, it is the usual practice for a miner to drill the hole six or eight inches less than the required depth. By pounding the steel it is often broken; it is, therefore, impossible to reclaim the hole; and it is necessary to make a new hole. What has been drilled is lost, and the plan of the cut is spoiled. Losing a hole, or drilling some holes to shorter depths than required, runs into the blasting time; and one poor hole may shorten the cut six to twelve inches. Then a foot of heading advance can be charged back to one improperly gaged drill bit, as follows:

3 men at $3.00 per day.....$9.00
5-foot advance .....$1.80 per foot for labor
4-foot advance .....$2.25 per foot for labor

Multiply the above labor cost by several thou-

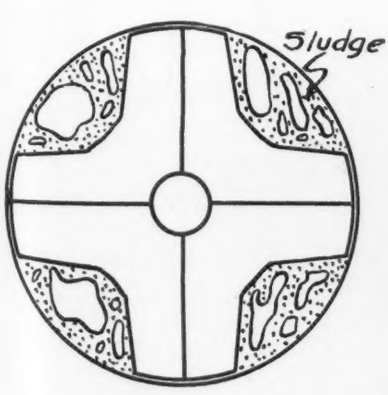
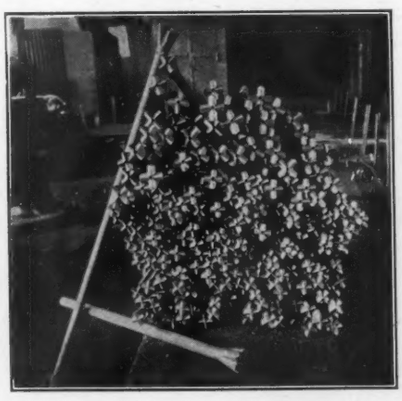


Fig. 9



A batch of steel which has been sharpened on a No. 5 sharpener.

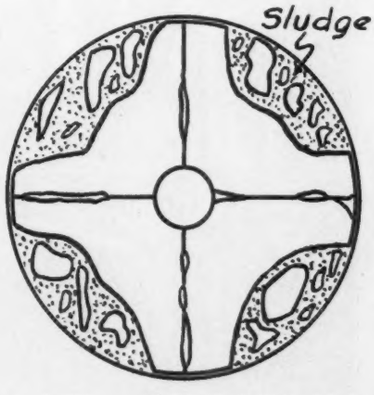


Fig. 10

sand feet of drift in a year, and charge the loss to poor bits.

Pounding of drill steel, which is due almost entirely to poor drill bits, should be placed at the very head of the drilling black list. It not only breaks drill steel and loses holes, but it is one of the main causes for repairs to machines. Chuck bushings are worn and cracked, and air is lost which cuts down the speed of the machines.

In the case of poorly tempered steel, bits which are too hard or too soft bring the same ultimate results as poorly gaged bits. Too hard a bit invariably chips off at the corners, and the gage is lost. The cutting edge chips off and is dulled, resulting in inefficient cutting. A soft bit loses gage, wears quickly, and, instead of translating its blows into cutting and advancing the hole, the machine is pounding its piston to pieces striking on a dead piece of steel. Broken machine parts mean the changing of machines, packing to shaft, hauling to toolroom, and repairman's time, to say nothing of the cost of replacement of parts.

The first thing to be considered under the head of poorly shaped bits is the wings which have too little stock back of the corners. Light corners mean quicker cooling when steels are tempered, hence you have hard, light corners which easily chip off. The wings should be clean cut down to the diameter of the steel, as shown in Figs. 8 and 9, so that cuttings will have maximum space through which to pass back of the bit, as illustrated in Fig. 9. When the former blocks in the sharpener are worn, the resultant wings are not clean cut and are of varying thickness from the center to the outside. This leaves little space for cuttings to work back, as may be seen in Fig. 10. In consequence, the steel binds in the sludge and the sides of the hole, and is driven through the sludge to get to the solid face upon which to work. The energy of the machine is wasted in boring through the cuttings instead of cutting clean rock. Often, especially if the ground is of a rather sticky or rubbly nature, or in a down hole, the cuttings will work back of the bit, and when the steel is withdrawn a wedging action against the cuttings takes place. This is one of the chief causes of stuck steel.

FIG. 11

The length of a standard shank is such that the piston striking it delivers its maximum blow. If the shank is too long the piston strikes it before the point of greatest impact is reached, delivering only part of the standard energy of the blow. The free drilling speed falls off.

With a shank too short, on the other hand, the full power of the blow is not delivered

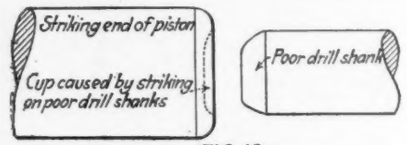


FIG. 12

when the striking end of the piston comes in contact with the steel after the body of the piston reaches the air cushion built up in the cylinder at the end of the stroke. Often the shank is so short that it allows the piston to over-reach; and, in doing this, the inner parts of the machine are pounded by the piston. This breaks the front cylinder washers, side-rods,

Cupped striking end of piston caused by poor shanks, showing break which would occur when perfect shank is used afterwards.
Perfect shanks made uniform do not cup pistons as fast as shown in Fig. 12
FIG. 13

springs, and front-heads; and, eventually, the front end of the piston is broken from the body. Broken drill parts inside a machine leave chips which, when the miner tries for a few minutes to start the machine, churn around and score the cylinder.

Now we come to the question of rough edges inside of the hole in steel for the water tube, Fig. 11. The water tube does not rotate with the steel, so that when the steel turns the burr acts as a cutter and cuts off the end of the tube, which must then be changed. The changing of this tube is done by the miner. Usually it is not much of a job; but it takes ten minutes. Sometimes the end of the tube is so battered that it will not go through the piston. Then the machine must be sent to the shop, taken apart, the rough end of the tube ground off, and a new one placed in as the machine is reassembled. This is an hour's job.

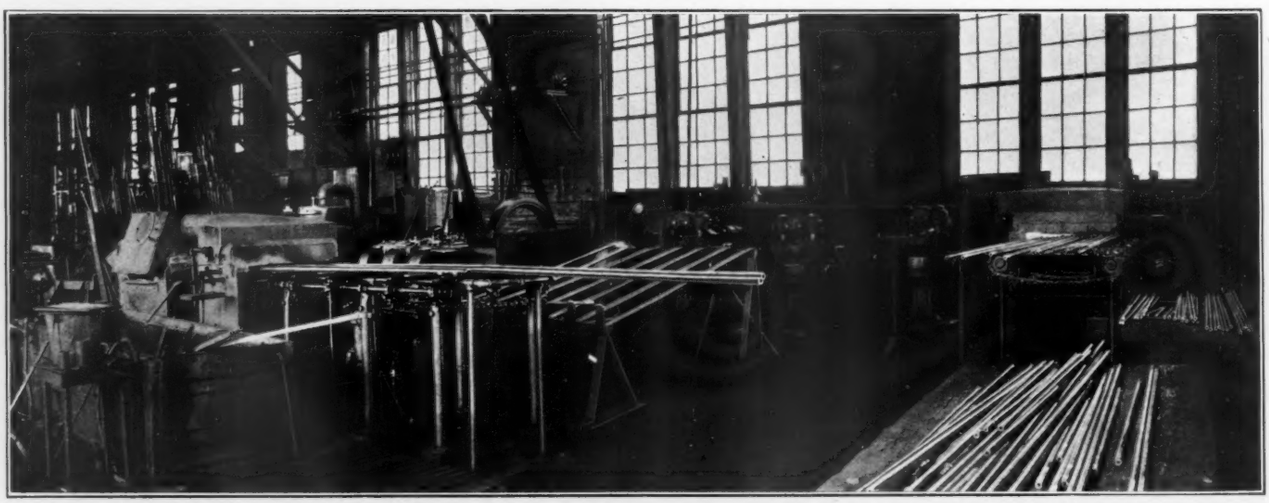
Shank ends, which are ground off too much, cause pistons to cup, Figs. 12 and 13. Then, when a standard shank is placed in the drill machine the piston is chipped off and the part rendered useless. Also, chips are hammered and churned inside of the machine, injuring other parts. Hard shanks chip with the same results. Soft shanks upset and stick in the chuck, which necessitates taking the machine apart to get the steel out. This is a job for the shop, and calls for an emery wheel. Time is lost underground changing machines and taking them back to the shaft.

Let us suppose the working face is such that by proper methods, tools, etc., it is possible to rig up at the beginning of a shift; to drill a complete round; and to blast going off shift. This is a common case. If enough delays occur the round is not finished. The following shift coming on must then complete the cut. This can be done in an hour or so, and the cut is blasted. However, the shift must wait for the smoke to clear, or be placed somewhere else. This upsets the schedule of the work, and also takes up the time of the bosses which could be used to advantage elsewhere. Every delay, every divergence from smooth running, every lost minute of the miners' time, gets into the debit column.

With modern sharpening machines, dies, dollies, formers, punchers, and shanking devices, it is easier to make perfect bits than poor ones. All of the faults enumerated are the result of an assumption that any old piece of steel will do for rock cutting. Every edge, angle, and feature of the best bits is built to perform a certain operation, and efficient drilling cannot be done if a single one of these features be lacking.

Poor bits are liabilities; good bits are assets.

(To be continued)



An oil furnace and three "Leyner" sharpeners forming part of the outfit of a well-equipped drill shop of a copper mining company.

Air-Driven Hoists Adaptable to All-Round Service

Twenty of These Handy Units Have Been Doing Much Good Work in a Big Shipyard for More Than Four Years

By A. S. TAYLOR

THE Army Mule, who hasn't heard of it! Without digging into his family history, it is enough for us to recall that for decades this adaptable, sure-footed, husky hybrid and his kind have proved their usefulness and their surpassing qualities of service under a wide range of demands.

In the days gone, the Army Mule has carried his burden or pulled his load under conditions that would have staggered the horse. And because of his maximum of ruggedness and willingness to work well on a minimum of food and care, the patient beast has played a not inconspicuous part in man's achievements both in times of armed strife and in the periods of peace.

The Army Mule, as an example of sturdiness and capacity to do things, has now a mechanical counterpart that is revealing a kindred fitness for a diversity of tasks. The "Little Tugger" hoist is the Army Mule's brother in adaptability; and the inventive mind has probably devised nothing for hauling, pulling, and lifting which lends itself more readily to changing needs than this simple and powerful small machine.

The story we have to tell here has to do with the services being performed by a score of

A No. 1H "Little Tugger" hoist. The lever at the left throws the drum in and out of gear; the lever at the right operates the throttle and starts the engine either to wind in or to pay out; and the large lever in front just above the adjustable base mounting controls the band brake.

"Little Tugger" hoists in one of the biggest and most progressive of the shipyards on the Delaware River. They were bought and installed at a time when economy of effort and speed of production were matters of vital concern; and since then they have proved their worth in a variety of ways.

Before describing these novel hoists and their applications it might help to a better understanding of their value if we have a mental picture of the setting in which they are placed. The yard of the Sun Shipbuilding Company is located at Chester, Pa., and was called into being originally to help us combat the sinister ravages of hostile submarines. It has eight building ways, three wet basins, and a floating dry dock capable of lifting a craft of 10,000 tons dead weight. On one of the ways, and now ready for launching, is a 14,000-ton tanker —a fine example of workmanship. While activities are slowed up because of the general slump in shipbuilding, still the yard is reasonably busy. When in full swing the plant employs a force of 4,000.

In all of its equipment, the Sun Shipbuilding Company's plant is typically up to date; and, as might be expected, compressed air and pneumatic tools are extensively used both in the shops and out on the ways and likewise aboard craft in course of completion or under repair in the wet basins. To satisfy the numerous and different needs of the yard, there are provided under one roof no fewer than nine electrically driven compressors. The five biggest of the machines have each a capacity of 5,000 cubic feet of free air a minute; those next in

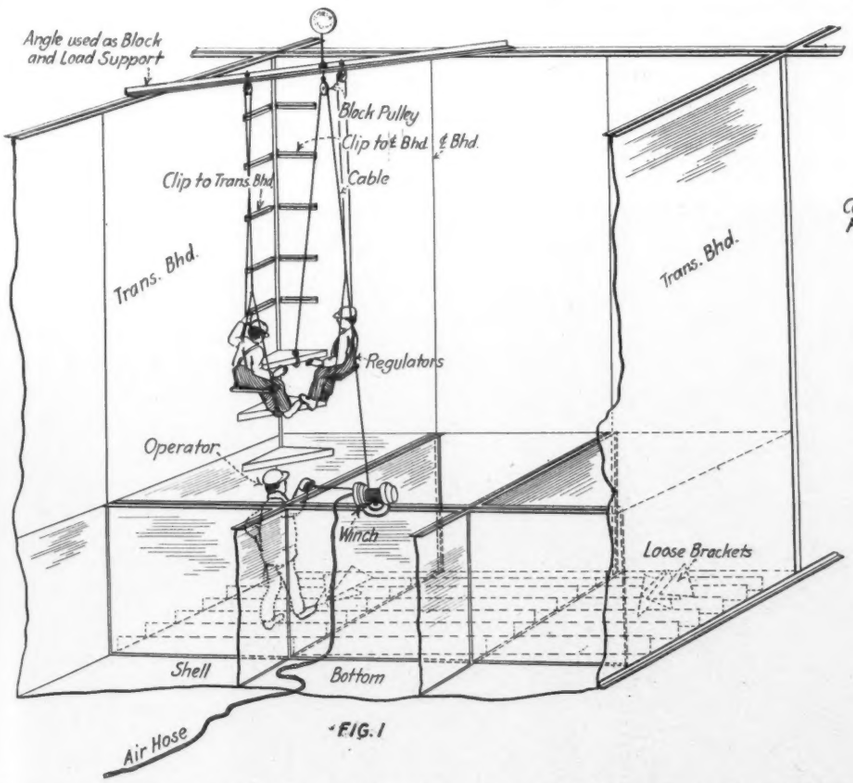
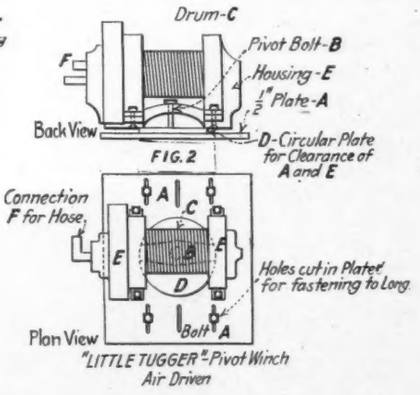


FIG. 1



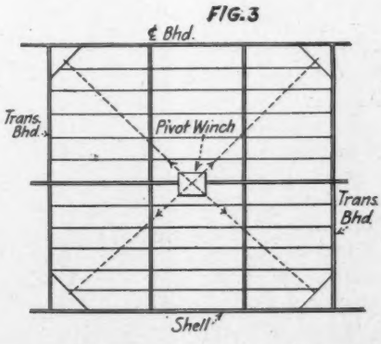
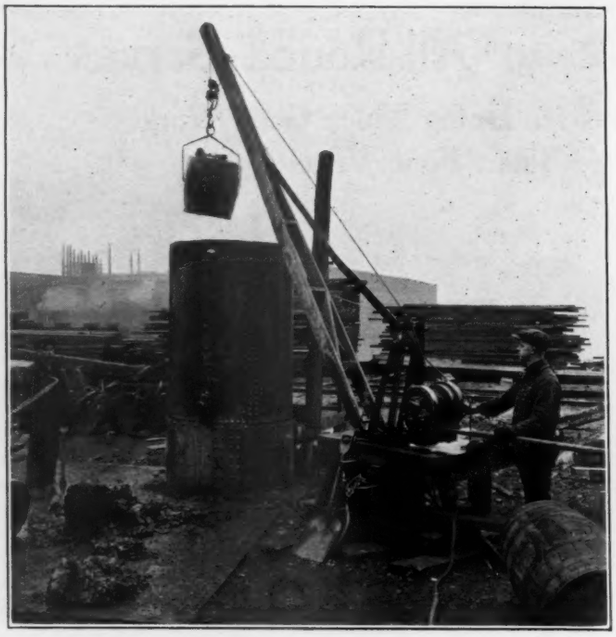
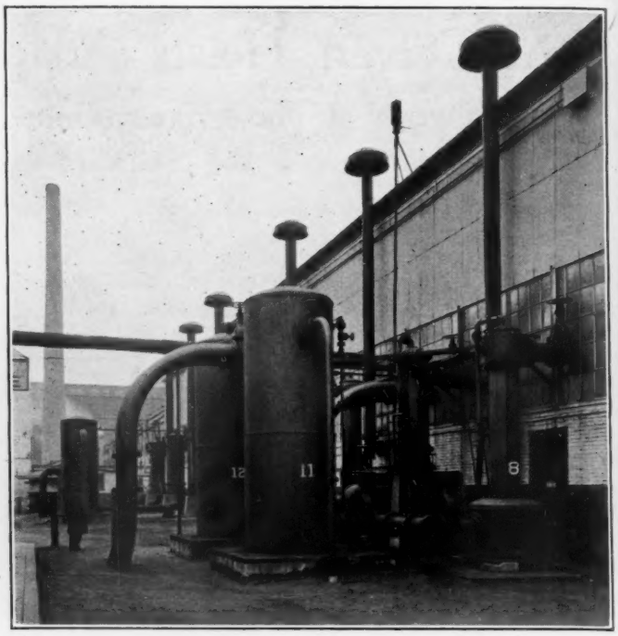


Fig. 1. General scheme developed at the shipyard for using a "Little Tugger" as a pivot hoist in lifting bracket plates into position for bolting during the construction of a vessel. Fig. 2 illustrates some of the features for securing the hoist in place. Fig. 3 indicates the manner in which the centrally placed hoist can handle brackets for all the neighboring bulkheads.



A crane equipped with a "Little Tugger" hoist used in handling for remelting the grease recovered from launching ways.



Aftercoolers and receivers of the great compressed air plant at the yard of the Sun Shipbuilding Company.

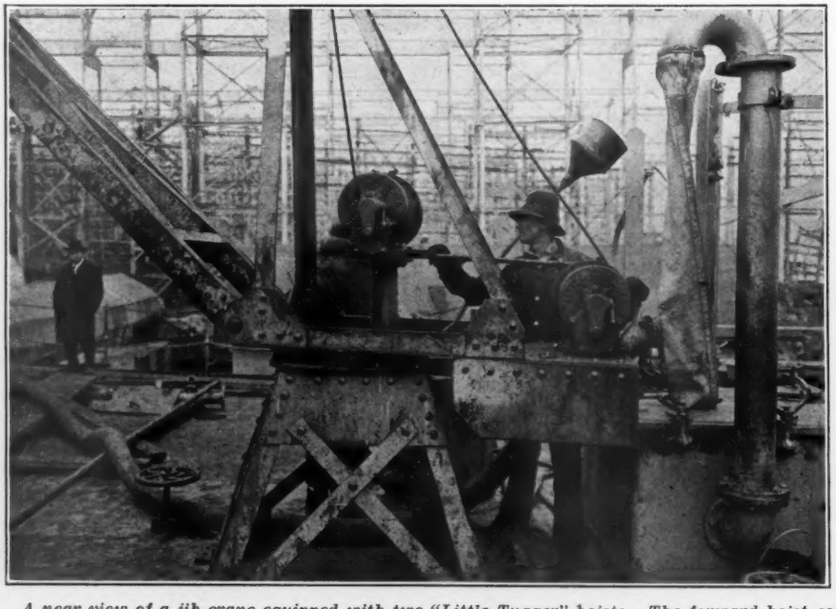
size are two compressors having each a capacity of 3,500 cubic feet; and the two remaining machines have individual ratings of 2,000 cubic feet a minute.

The compressed air from these various units, after passing through a corresponding number of aftercoolers, is led to suitable receivers—placed out doors, and thence piped everywhere about the yard to convenient points from which connections can be made, by moderate lengths of flexible hose, to pneumatic tools of one kind or another. This system of distribution includes, of course, the building ways, the wharves around the wet basins, and the taps adjacent to the floating dry dock. This explanation is necessary because compressed air is the driving medium employed there for the operation of the "Little Tugger" hoists. Incidentally it might be mentioned here that the hoists are also built for steam drive, and the latter differ only in some minor details from those under consideration.

The "Little Tugger" hoists in use at the yard of the Sun Shipbuilding Company are designated by their makers as type No. 1H; and when ready for mounting, but without a cable attached, one of these machines weighs but 285 pounds. Depending upon whether a steel wire cable of 5/16 inch or of ¼ inch in diameter is employed, the drum will take care of 450 feet or 700 feet of line. At a rope speed of 85 feet per minute, with an air pressure of 80 pounds, a No. 1H is capable of lifting a load of 1,000 pounds. Indeed, it is claimed that hoists of this sort weigh anywhere from 125 to 500 pounds less than other hoists of a like capacity. Because of this relative lightness and the ease with which the "Little Tugger" can be mounted it may be quickly set up or taken down and moved anywhere to meet the needs of the hour. As a matter of fact, more than half of the hoists of this kind at the Chester plant have no permanent positions.

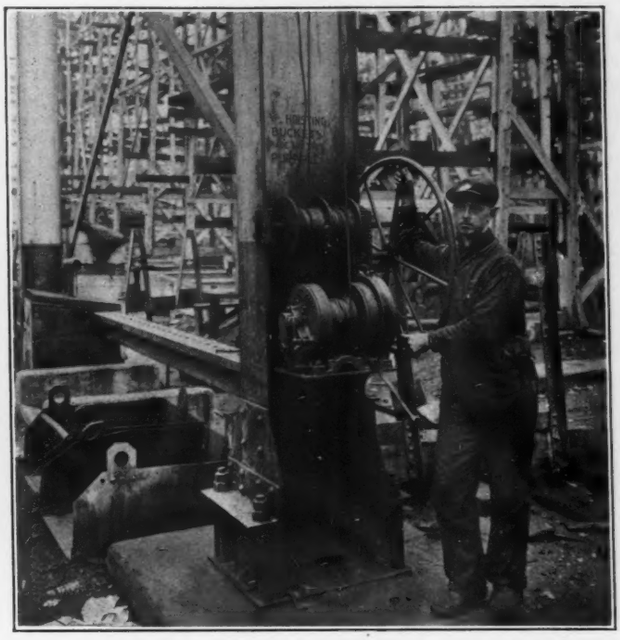
As several of our illustrations make clear, with the exception of the drum, there are no moving parts of any sort exposed on the "Little Tugger"—all gears and shafts being covered. Owing to this provision, there is nothing to catch an operator's clothing while the machine is running. This feature is valuable, and especially so when the hoist is located where the light for any reason may be dim or uncertain. Indeed, the risk to the attendant or an unheeding person near by is reduced to a minimum. The factor of mechanical safety is likewise a large one because of the simplicity of the design and the durability of the materials used throughout in the construction of the hoist.

Superficially, there is nothing to indicate the actual character of the prime mover. The driving mechanism is somewhat novel, and consists of an engine of the square-piston type which is capable of giving four impulses with every revolution. Owing to the fact that there are no dead centers the hoist can be started in any position. The engine is reversible, and is controlled by a small lever at the side where the connection with the air line is made. By throwing the lever forward the hoist winds in, while by pulling the lever backward the drum turns in the opposite direction and pays out the cable. Functioning in the latter way the engine virtually acts as a brake in regulating or timing the speed of a descending load. The control lever is centered between two opposing springs and is, therefore, returned instantly to the stop or neutral position when the operator lets go of it. This is a safety feature which has been protectively effective on numerous occasions. The speed of



A near view of a jib crane equipped with two "Little Tugger" hoists. The forward hoist controls the up-and-down movement of the crane while the after hoist lifts or lowers the weight to be handled.

The double-hoist jib crane in service aboard a tanker undergoing extensive repairs at the yard of the Sun Shipbuilding Company.



A close-up of a "Little Tugger" hoist installed between two building ways at the Chester plant.

the hoist may be varied at will and within a wide range of revolutions per minute.

The engine is thrown in or out of gear with the drum by a clutch that is manipulated by a small lever at the side of the hoist opposite the engine control. By way of an additional safeguard, the "Little Tugger" is equipped with a powerful band brake, fitted with a woven asbestos lining. This brake is brought into service by a long lever which is keyed to a double-screw shaft set at right angles to the longitudinal axis of the drum and just above the hoist's supporting bedplate. In short, the brake lever is placed where it will be handiest for an operator; and when the brake is swung to the "on" or the "off" position it will remain there until it has been purposely shifted.

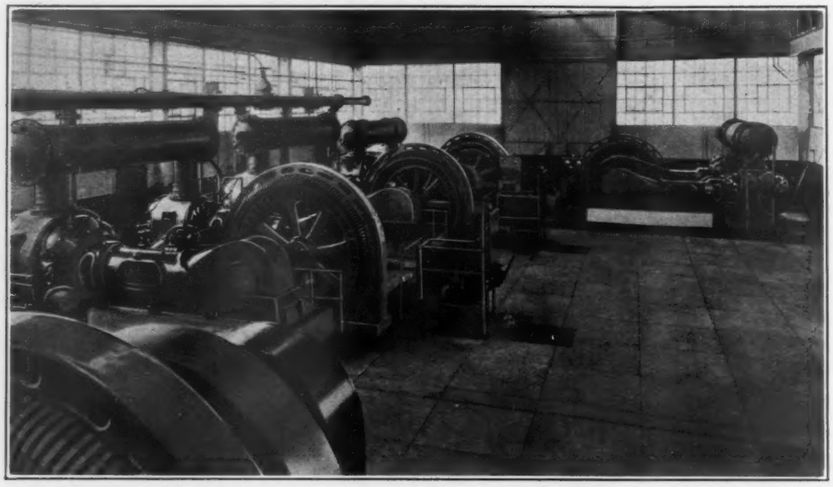
The foregoing distinctive characteristics of the "Little Tugger" hoist have been deliberately mentioned so that the reader may appreciate wherein this adaptable apparatus differs from the usual run of mechanical hoists and, therefore, lends itself to many kinds of jobs and successful operation in the hands of all sorts of workers. A shipyard is a place of varied demands when it comes to moving weights and masses of endless descriptions; and experience has disclosed that much time and effort can be wasted in the shifting and the raising of loads either by hand or by the employment of disproportionately large or powerful facilities.

Like all modernly equipped plants of its kind, the Sun Shipbuilding Company has installed at its building slips big electrically operated traveling cranes capable of handling loads of from fifteen to 20 tons dead weight. These cranes run the whole length of the ways and can serve any part of a vessel beneath them during her construction prior to launching. When it is realized that seagoing craft are fashioned of steel plates and angles, bound together by many thousands of rivets, and have inside of them hundreds of feet of piping of a variety of sizes, the amount of lifting that has to be done before a craft is ready to be put overboard is staggering. The requirements may range all the way from a keg of rivets, bolts, or nuts to a single mass of several tons; and only in handling weights in keeping with their magnitude and cost of operation is it economical to utilize the big overhead cranes. Thousands of lifting problems about a ship on the ways involve the raising and the lowering of unit masses weighing but a few tens or possibly a few hundreds of pounds at the outside. It is for jobs of the latter sort that the "Little Tugger" hoist is especially suited, for it can do this work quickly and cheaply.

Recognizing this, the management of the Chester plant put a single pneumatic hoist of this type at a convenient point along the trackway between each pair of slips. The cable from this hoist runs up and out to the end of a swinging boom, placed at a sufficient height on the supporting structure for the big traveling crane, that reaches over and onto the open deck of a vessel building on either of the flanking slips. The boom is maneuvered by a separate line actuated by an independent drum, which, in its turn, is controlled manually by an attached bull-wheel. These several hoists have been extremely useful in raising and in lowering rivet forges, gas tanks, buckets, pipe fittings, inside staging, etc. Indeed, their many services would fill a long list.

As an example of how much neglect these machines will stand and still perform well, it might be stated that on the occa-

"Little Tugger" hoists have been found very efficient and labor saving in hauling into position the heavy sections of timber forming the ground and the sliding ways of the launching ways.



A view of the interior of the compressor house showing five Ingersoll-Rand, class "PRE," direct-connected, electric-motor-driven air compressors, each of 5,000 cubic feet per minute capacity. These machines supply air to all sorts of pneumatic tools and equipment employed throughout the plant of the Sun Shipbuilding Company.

sion of the writer's visit to the yard one of these exposed hoists was chosen offhand for demonstration and was called upon to lift a big iron bucket weighing 300 or 400 pounds. It is safe to say that that hoist had not been used for the better part of a year, and yet, when the air was turned on, the apparatus disposed of its load without a hitch and in spite of gummy lubrication. It proved to be a good double of the Army Mule for dependability.

The 14,000-ton tanker, which was still on the blocks but ready to be put overboard, had had her launching ways, for the most part, assembled beneath her by means of two "Little Tugger" hoists—one on either side of her. For the time being, each of these hoists was bolted to a piece of heavy planking which was similarly secured in a horizontal position to two of the shores wedged upright against the bottom of the ship. Anchored in this fashion the hoists were able to pull up, on rollers, the various heavy sections of both the ground and the sliding ways and to draw them into their respective positions. In this manner, two men and one hoist were able to do work that would ordinarily require from eight to twelve men when moving these pieces of timber by hand.

It takes a good many hundreds of pounds of grease to lush the launching ways of a large ship, and this lubricant costs a good deal of money. Therefore, it is the practice in most shipyards to recover as much of this grease as possible both from the sliding ways and the ground ways after a craft has been put in the water. The stuff is scraped off from the timbers and commonly has caught in it such foreign bodies as bolts, washers, nuts, chips, etc. At the Sun shipyard, the retrieved grease is heated in an improvised rendering tank and drawn off through a valve, at a suitable height, to get rid of the precipitated mud, metal scrap, etc. A make-shift crane, fitted with one of the air-driven hoists, is used to raise the solidified grease from the ground and to dump it into the open-topped caldron.

Probably one of the most suggestive adaptations of these hoists at this same plant is that of a jib crane which was recently seen set up on the deck of the big tanker *J. N. Pew,* then undergoing repairs. It will be recalled that that vessel, while on the floating dry dock, suffered a severe explosion—due to the unexpected ignition of petroleum gases in some of her lower tanks. The explosion was so violent that it practically cut the steamer in half by blowing out the adjacent shell plating and by ripping great gaps in the overlying steelwork and deck. The job of making the *J. N. Pew* fit again for service involved cutting clear and lifting out of the way all of the shattered and twisted steelwork and hoisting and lowering approximately into position a corresponding amount of new plating, angles, etc. It also meant getting aboard rivet heaters, a considerable number of pneumatic rivet passers, and a varied assortment of other essential equipment and facilities. To speed up these operations, a jib crane, provided with two "Little Tugger" hoists, was mounted at a convenient point on the deck of the tanker; and a couple of our illustrations show this crane in use.

As one of the pictures indicates, each of the hoists has a distinctive function to perform in connection with this revolving crane. That is to say, one of the hoists lifts or lowers the jib while the other hoist serves to handle the weight to be dealt with. This dual arrangement affords a very flexible crane which is capable of moving considerable loads quickly and with precision. The crane has been found to be a labor saver and a great convenience.

The "Little Tugger" hoists have been employed at the Sun shipyard for more than four years, and are commonly looked upon as handy helpers which can be rigged up most anywhere. As one of the yardmen expressed it: "Those little hoists are wonders, and they will work and do all that you put up to them as long as you feed them the air they need."

COMPLETION OF A LONG NEW ZEALAND TUNNEL

THE 5½-mile Arthur's Pass Tunnel, connecting Otira and Bealey on the east and the west coasts of the South Island of New Zealand, is now completed, and will be in full service this year. Work on the tunnel was variously interrupted.

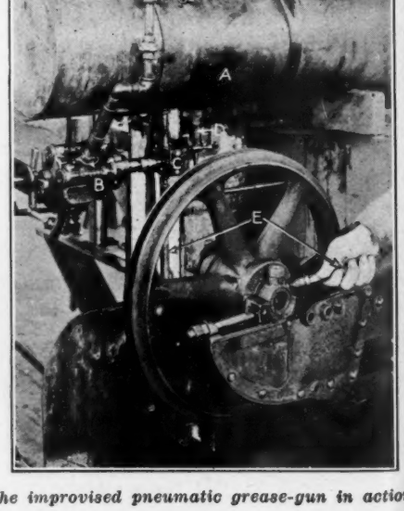
An illustrated account of the undertaking, then well in progress, was given in COMPRESSED AIR MAGAZINE, June, 1909. The tunnel is 2,400 feet above sea level, with a continuous grade of 3 per cent. It is for a single-track line, of 3½-foot gage, sixteen feet nine inches high above subgrade, and thirteen feet wide at subgrade, with sides flaring to fourteen feet six inches at the springing of the semi-circular arch.

Water power was used for the entire work, with Ingersoll-Rand compressors and drills. Although the tunnel is in solid rock it is lined with concrete.

COMPRESSED AIR USED TO LUBRICATE TRACTORS

ANY USER of compressed air has at his command the power to put into effect numberless small savings in time and in money by practicing a little ingenuity. The installation shown in the accompanying photograph was noticed recently in the plant of a Western manufacturer. The wheel in the picture is the front idler, and is part of the truck assembly for a track type of tractor which the concern in question makes.

Before some of the truck parts reach the final assembly floor the bearings must be filled with lubricant. Formerly this was done with a hand grease-gun. This method was too slow for the foreman, so he got an old air drill from the tool room and a small gear oil-pump from the stock room. These he mounted below the storage tank, A, containing the lubricant; coupled the air drill, B, to the pump, C; and connected the pump with the tank. Under the tank just a little to the right of the pump, is a gas burner, D, for keeping the oil warm. From the pump a piece of flexible metal tubing, E, the end of which only is visible in the picture, leads to the "alemite" fitting on the truck. A turn of the valve, and compressed air does in a few seconds what was formerly done in as many minutes by the hand grease-gun.



The improvised pneumatic grease-gun in action.

INTERESTING ENGINEERING SOCIETY BANQUET

THE ENGINEERS' Society of Northeastern Pennsylvania held its twenty-sixth annual banquet in the Hotel Casey, Scranton, Pa., at seven o'clock on the evening of February 1. All told, 365 members and associate engineers of northern New Jersey and the anthracite coal regions of Pennsylvania gathered in a noisy, jolly, get-together banquet preceding excellent addresses by engineers of national prominence. George E. Stevenson, the retiring president of the society and of the firm of Stevenson and Knight, consulting engineers of Scranton, introduced Dr. John M. Thomas, president of the Pennsylvania State College, as the toastmaster. A brief address, which is appended, was also delivered by William Wilhelm, the new president of the organization and manager of the Scranton office of the Ingersoll-Rand Company.

Retiring President Stevenson, in his speech, told of the efforts of members of the society to have the act requiring engineers to produce a license, passed at the 1921 session of the Pennsylvania legislature, declared unconstitutional. "Personally," he said, "I underwent the process of being arrested in Monroe County to find out just where the act stands."

The testing of this act, which seems utterly out of place in a present-day statute book, should be of the utmost interest to all engineers, as several near-by states, from what can be learned at this time, are only awaiting the outcome of this test of the Pennsylvania law before enacting similar legislation. Briefly, it requires any engineer acting in a consulting or advisory capacity to hold a state license, which is granted only at will by a political board annually appointed.

Toastmaster Thomas, in his brief address, recounted what has been done by engineers in bringing this country to its present position. He said that much of the existing prosperity of the nation rests upon the work that has been performed by engineers, and he predicted that the attainments of engineers will become even more important in future days.

Dexter S. Kimball, Dean of the College of Engineering of Cornell University, was the principal speaker of the evening, and in his address dealt largely with the work now being performed by engineers. "The plan of engineers today," he said, "is for national leadership." Touching on the accomplishments of engineers in both the agricultural and mechanical arts, the speaker declared that the big problem confronting the country now is virtually a mechanical one. "Civilization at present," he continued, "is the work of engineers and will continue to be the work of engineers. The problem of production is the key to prosperity.

"Primarily, the problem of engineers is one of getting things done. Essentially, the engineer is honest, and upon this honesty depends much of the progress of the nation. The engineer stands between labor and capital. It is his business to do so. The engineer protects himself for the future by losing himself in the records of the past."

That the engineering type of mind is coming to the fore in the management of the country, was asserted by Dean Kimball. He declared that military leadership has been tried and found wanting, and that legal leadership has also failed to prove itself best for the country at large. "We hope," to quote the Dean, "that we have passed the day of military leadership.

"Engineering has brought civilization up to the heights on which it now stands. Furthermore, it is the tendency of the engineering type of mind to combine more and more with the business type. Regardless of what we may say or think, the engineering type of mind has largely been responsible for the growth of the country."

P. G. Rimmer was chairman of the committee that arranged for the banquet. Other members were, S. D. Dimmick, L. F. Mitten, W. E. Walthal, L. G. Van Nostrand, F. L. Smith, R. H. Buchanan, G. L. Bascome, and E. J. Mulvehill.

William Wilhelm.

George E. Stevenson.

Seated at the speakers' table were, Dean Dexter S. Kimball, George B. Hadesty, Dr. John M. Thomas, William Wilhelm, F. L. Smith, F. H. Hemelright, George G. Brooks, F. J. Platt, Boyd W. Musser, S. D. Dimmick, W. W. Inglis, George E. Stevenson, P. J. Casey, and Robert McLave.

In addressing the society, Mr. Wilhelm spoke as follows:

"I thank you for the honor and the confidence you have bestowed upon me by electing me to the office of president of this society. In accepting, I have but one rule to guide my conduct, and that is, I will do the best I know how. I frankly confess that I have been a poor club member; but, in taking a careful inventory of organizations of this kind, I find that I am not the only one who has been shirking duty. You will find that engineers as a whole, because of their training, have not the fine touch of romance which urges them to take a keen interest in societies and clubs.

"In the beginning, engineers are trained to understand the fine art of the omission of non-essentials, and thus they become temperamentally fitted to do things. This the engineers and artisans have inherited from their predecessors in the profession, as we learn, by looking over the records of the ancient Greeks or Romans, that great tasks were performed and yet little was recorded in detail of their useful discoveries to pass on for the benefit of mankind.

"For instance, Domenico Fontana, of the sixteenth century, set up on end, in Rome, the Egyptian obelisk—a wonderful piece of work. The Egyptians quarried that stone and carried it 150 miles; but the Romans transported it 750 miles and never said a word about it. We know but little about how they accomplished this task. Yet, in the same period, there were recorded many barbarous acts committed by mankind.

"So the engineers of today are, naturally, but revealing the traits handed down to them from generations past, and say but little about the work they perform. They pass by unnoticed; and people, in general, seem to think that their duties are nothing out of the ordinary and thus belittle their profession.

"They are governed in their work by the hard and fast rules and laws of science. If they make a mistake there is no excuse to offer: it is simply what the Americans vulgarly term a 'bull,' and the public is not slow to say that it was the fault of their planning. Unlike lawyers, they frequently have no tangible excuse to offer as to how the mistake was made.

"But by the aid of engineering and scientific societies, much has been done in latter years to record in detail the great things that have been accomplished by the master minds of the last few decades, so that their works may be intelligently handed down to posterity. As a result of these activities, we need have but little fear today that the accounts of valuable engineering discoveries and achievements will be hidden or lost to the future.

"I ask the hearty coöperation of all members of this organization to help make it a success and to carry out the plans formulated by my predecessor. To illustrate the kind of an organization we want I am going to tell a story, not particularly a new one, because they are scarce. We are told that the favorite story of George Washington, the illustrious Father of our Country, and the one he repeated oftenest, was not new: that it originated in Athens 365 years before the birth of Christ.

"The story is that of a boy, who was crossing the plains in a stage coach in the early days. One morning he asked permission to ride with the driver. The youth was soon attracted by the skill with which the driver handled the whip, and asked the coachman to see if he could hit the ears of the lead horse. The request was no sooner made than the act was performed. With a swing of the great lash, the driver clipped the ears of the lead horse. A little further on they espied a bunch of red leaves hanging on a bush, and the boy said, 'Driver, let's see you hit those leaves.' He promptly responded, and cut the leaves from the branches. A little further on the boy saw a hornet's nest hanging from the limb of a tree, and said, 'Driver, let's see you hit that hornet's nest,' but this time the driver replied: 'Boy, a horse's ear is a horse's ear, a red leaf is a red leaf, but that hornet's nest, Oh, boy, that nest is an organization!'

"So I am going to ask you to help me to make the Engineers' Society of Northeastern Pennsylvania like that hornet's nest, an organization."

Statistics lately compiled by the Bureau of Railway Economics reveal that the world's railways, in 1920, totaled 748,005 miles. Of this trackage, 264,373 miles are in the United States. In other words, about 35 per cent. of the railway mileage of the world is maintained by Uncle Sam.

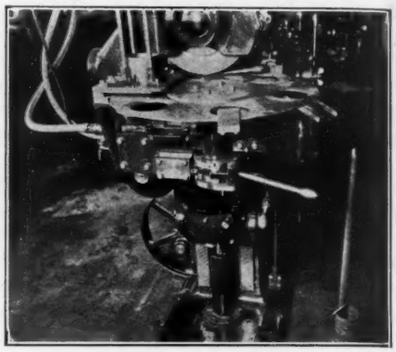
AUTOMATIC GRINDER USES COMPRESSED AIR

THE STEADILY growing demand for internal combustion engines and the ever increasing production of automotive vehicles have called for the manufacture of millions and millions of piston rings annually in recent years. To turn these rings out rapidly and in sufficient quantities has necessitated the development of special machine tools of an automatic or a semi-automatic character. Among these the Arter automatic piston ring grinder is of special interest because of the way in which compressed air is utilized.

The machine is really a development of the rotary surface grinders built for years by the Persons-Arter Machine Company for the piston ring industry. Ring manufacturers long realized the desirability of some kind of automatic device that would feed rings onto the chuck; and because of this manifest need various efforts have been made to evolve a satisfactory solution of the problem. Success, however, has rewarded only a few of these endeavors.

The real cause for failure of most of these apparatus lay in the fact that the feeding attachment was made to operate by a mechanical movement. Mechanical movements cause jarring, and this is apt to lead to chatter marks on the work. As is well known, a grinder must be rigidly built in the first place, the spindle and bearings should be nicely fitted, and the machine ought to be mounted on a concrete foundation whenever possible.

Like others in the same field, the Persons-Arter Machine Company also experimented with a mechanically operated attachment, but soon discarded this in favor of one actuated by compressed air. There were the best of reasons for this. Compressed air affords a very flexible means of control, and its use enables the indexing movement to be performed smoothly and without any perceptible jar. Further, the availability of compressed air makes it easy to provide a blow-pipe on top of the chuck for the purpose of preventing the accumulation of grinding grit. The stream of air keeps the surface clean and blows the grit into a hood which is connected with an exhaust system. All ring grinding is done dry.

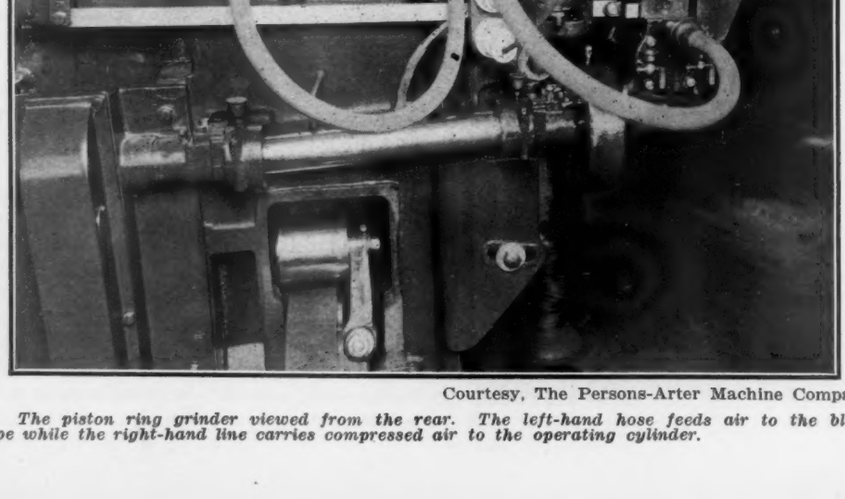


A front view of the machine showing the carrier plate with holes in it, the vertical grinding disc, the blow-pipe just below the disc, and a ground piston ring descending the chute on the right and beneath the carrier plate.

The operation of the mechanism is extremely simple. Rings are stacked in a hopper, and each hole in the carrier plate slides a ring from the bottom of the stack onto a constantly revolving magnetic chuck. The same indexing movement carries the ring, when ground, off the chuck and down a chute to a loading stem. An automatic switch controls the action of the chuck. A ring is ground at each stroke of the ram, or wheel slide, so that the indexing movement has to be timed with the slide. Movable dogs on the wheel-slide rack, regulate the length of stroke of the slide and also actuate a lever, which is attached to the valve sliding rod at the rear of the machine.

The air cylinder is operated by a sliding valve, having a U-type port construction. The cylinder is double acting, that is the air pushes the piston both forward and back. The piston rod has rack teeth cut in it which are in mesh with teeth in a gear segment. This gear and the cam, located just below it, are free on the spindle. However, to the cam is attached an arm containing a pawl, which engages one tooth in a series, cut into the periphery of the ratchet wheel. Just above this ratchet is a disc having six notches, the disc and the ratchet being pinned together and keyed to the spindle. As the spindle indexes, the cam pushes back a locking pin until one of the holes in the carrier plate is directly over the chuck. Then the locking pin drops into a slot in the disc and holds the plate in a fixed position. The backward movement of the piston rod brings the pawl and the arm back but without disturbing the position of the plate.

The air consumption of the entire device, including the blow-pipe on the chuck, is about four cubic feet per minute; and a pressure of 30 pounds is required. Inasmuch as the apparatus is entirely automatic in its functioning one man can look after three machines at a time.



Courtesy, The Persons-Arter Machine Company.

The piston ring grinder viewed from the rear. The left-hand hose feeds air to the blow-pipe while the right-hand line carries compressed air to the operating cylinder.

Shooting Seaplanes from the Deck of a Speeding Ship

The Compressed Air Catapult Promises to Revolutionize Maritime Aviation

By S. G. ROBERTS

WHEN THE flying machine was in its infancy, aviation experts, both in America and abroad, recognized the potentialities of aircraft as scouting aids to the fighting fleet in widening the range of vision, but the stumbling block to practical usefulness was the lack of means by which the aircraft could be sent aloft from the deck of a ship at sea and afterwards return to that mobile base upon the completion of its reconnoitering flight.

Ten or twelve years ago, the airplane had decidedly limited capabilities, and much had to be done to it to suit it to seagoing service. This is mentioned in order that we may have a better understanding of what has been accomplished in the meanwhile to transform the flying machine virtually into a dirigible projectile of very long range and of tremendous destructive powers. In short, to make it a man-guided missile which can far outreach the greatest of modern rifles.

When experiments were first conducted looking to intimate coöperation between the airplane and the ship of war, the flying machine could not rise from or alight upon the water—the hydroaeroplane, which has now become the seaplane, had not then been evolved. The problem, therefore, was to devise facilities by which aircraft could be given an initial impulse while descending a long platform built upon a vessel's deck and, conversely, which would enable them to use this same runway for alighting when returning to the ship.

Aside from the objectionable length of these ramps, they were undesirable because they obstructed the arcs of fire of a number of important guns, and to just that extent they reduced the military effectiveness of the battle craft. Fully alive to the shortcomings of expedients of this sort, Captain Washington I. Chambers, U. S. N., back in 1912, set about designing a launching mechanism which would "shoot" an airplane from the deck of a ship after an initial run of not more than half a hundred feet. He devised a catapult, and by one bold stroke he blazed the way for a very radical departure in naval aviation.

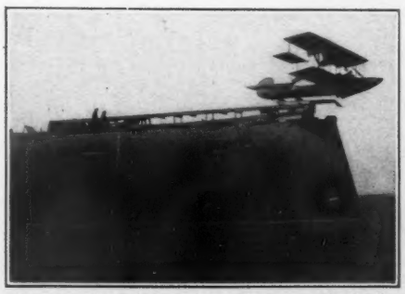
Early in 1912, the Chambers catapult, in a crude experimental form, was tested at Annapolis, Md., and at that time the contrivance was mounted rigidly upon a wharf. The launching impulse was obtained from compressed air acting upon a piston suitably connected with a multiplying purchase—the wire rope, in its turn, pulling a small car, traveling upon rails, which carried the 'plane. Both the car and the flying machine were free to lift from the track of the runway during any part of the stroke of the piston. The procedure was to start the airplane motor; and when this had attained full speed then air at a pressure of 290 pounds was turned abruptly into the cylinder of the catapult. One can readily imagine the sudden and jerky tug which was given the aircraft as it was started from a standstill and accelerated to a velocity sufficient to sustain it in the air until its engine could furnish the needful driving force.

The first tests laid a heavy tax on the courage of the volunteer pilot, for it was fully realized that he was risking his neck in demonstrating a makeshift and unfamiliar apparatus. What actually happened at Annapolis has been thus described by the inventor: "The machine reared at about midstroke and, as a cross wind was blowing, the right wing was thrown up, and a corkscrew dive into the water resulted. Lieutenant T. G. Ellyson, the aviator, managed the machine, and his iron nerve was fully equal to the occasion. Notwithstanding his precipitous plunge, he expressed himself as fully satisfied that the launching shock ought not to deter any good pilot. It was gratifying to discover that no part of the machinery or of the fittings was ruptured or showed any signs of weakness."

BARON MUNCHAUSEN, that great exponent of unbridled imagination, has described somewhere in his inimitable memoirs how he reconnoitered the enemy's position during one of his exploits from astride a friendly shell, which he nimbly mounted just as it left the gun.

When midway in his skyward journey, he jumped onto an approaching hostile projectile and thus rode back to his base, where he reported what he had observed of the disposition of the foe's forces.

Few, if any of us, that have read of the Baron's doings, have ever believed that anything like such a deed were possible, and yet modern inventiveness has, in effect, made such a performance practicable and, thereby, has laid the foundation for very radical changes in naval strategy. The present story stells how this has been achieved.



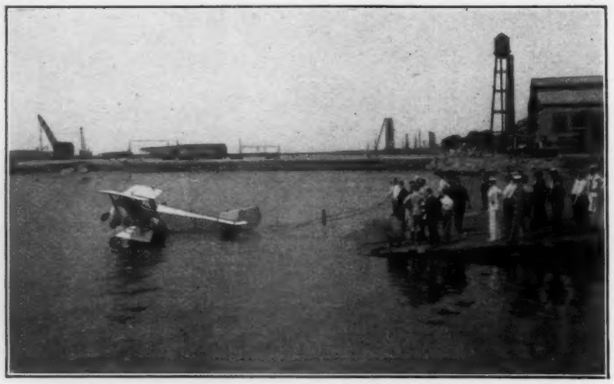
The seaplane catapult as first installed aboard a fighting ship. The aircraft is being catapulted from the U. S. S. "North Carolina."

Some months later—to be exact, on the 12th of November, 1912, the catapult was again tried out, but at the Navy Yard in Washington, D. C. At that time, the apparatus was set up on a float so that the flying machine could be pointed toward the wind during launching and in this way avoid any cross currents while taking advantage of the oncoming wind to help "float" the 'plane when it was projected into the air. Other improvements included equipping the supporting car with reverse flanges which could hold the truck down to the rails and prevent it from leaving them until the run was completed; and the apparatus was provided with a balanced valve, which was gradually opened by a wedge-shaped cam attached to the traveling block on the piston head so that air would be admitted to the piston cylinder progressively. This arrangement reduced considerably the jar or shock incident to starting the airplane from a standstill and imparting to it the necessary soaring momentum within a span of but 40 feet. The flying machine was held in contact with the launching car by an iron strap which was tripped automatically and released when the truck reached the outer end of the rails.

Before Lieutenant Ellyson demonstrated the efficiency of the modified catapult, the installation was subjected to several preliminary tests, in which sand bags represented the dead weight of the flying machine and the aviator. The speed and the pressure curves obtained in this manner were thoroughly reassuring, and they disclosed that the method could be counted upon to give ample velocity to satisfy any reasonable requirements. This was confirmed when Lieutenant Ellyson took the pilot seat and was shot into the air in much the way that "clay pigeons" are sent skimming for the marksman. Primitive as the whole equipment was, it nevertheless represented a step forward in naval aviation of momentous significance; and it proved how compressed air could be utilized in solving a very difficult problem.

Following the tests at Washington, plans were drawn up for a catapult which could be located on top a battleship turret, but funds were then lacking, small as the sum needed was, to build the apparatus. The idea was that a catapult of that sort could be placed out of the way of the blast of the guns while the turret could be made to play the part of a turntable so that the flying machine might be pointed into the wind to assure a thoroughly satisfactory take-off.

It was not until 1915, however, that money was available for the construction of an airplane catapult; and by that time certain changes in the arrangement of the main battery of our superdreadnoughts made it impracticable



The emergency flotation gear in action during a test demonstration. Land 'planes that may have to fly over water can thus be safeguarded from sinking. When descending toward the water the aviator opens a valve, connected with a small air bottle, and the flotation bags are quickly expanded.

Hanriot airplane, equipped with collapsible air bags, seen folded above wheels of landing gear, which are inflated just before the craft settles upon the water. The filling of the bags takes but a moment and is an emergency protective device.

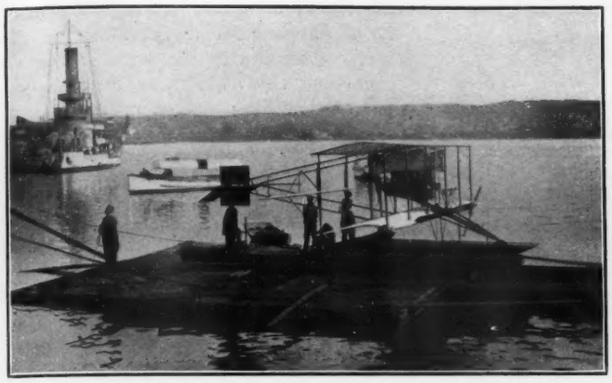
to use any of the turrets for the support of the launching device. Study made it clear that the catapult should be located as far aft as possible. where a ship's movement in a seaway is relatively moderate, and that the equipment should be close down to the deck to facilitate putting the 'plane on the catapult car.

The 1915 catapult was sent to the Aeronautic Station at Pensacola, Fla., and its preliminary tests were conducted from the low deck of a coal barge. Those trials were so satisfactory that the apparatus was shortly afterwards removed from the barge and installed on the after main deck of the armored cruiser U. S. S. *North Carolina,* which was at that date assigned to aviation work. Various flights were made from that ship to gain experience in launching flying boats from a moving base. The first essays were conducted with the battle craft steaming at six knots an hour, and, as the pilots became more expert, the vessel gradually increased this to her regular cruising speed of twelve knots an hour.

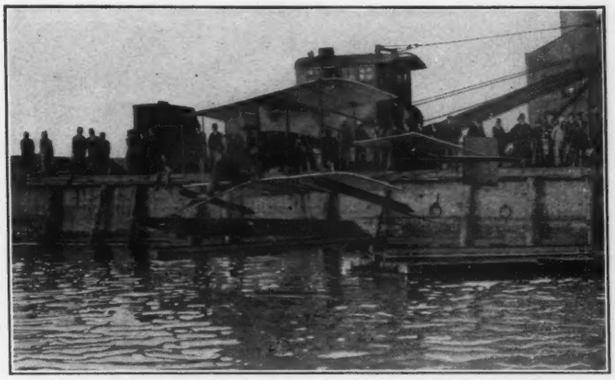
Despite the fact that the flying boat was at that time of an early model and decidedly heavy, and that one of the pilots weighed fully 200 pounds, the catapult functioned perfectly. The aviators felt no appreciable shock during the launching period, and their only sensation has been described as one akin to that of receiving a sudden blast of air in the face. The catapult built in 1912 had its air stored in an improvised and somewhat leaky tank, while the catapult carried aboard the U. S. S. *North Carolina* drew its operative air from the ship's regular torpedo air service and at a pressure of 300 pounds per square inch. Further, the valving arrangement was modified so as to induce a smooth and progressive speeding up of the driving piston and, consequently, insured an easy acceleration of the launching car. The travel of the latter was about 50 feet, and within that short run it was possible to start the seaplane from a standstill and to give it a launching speed of 50 miles an hour. The impulse piston moved only 50 inches, but the associate multiplying wire-rope purchase drew the truck the needful distance.

The catapult mounted aboard the U. S. S. *North Carolina* was not a complete solution of the problem, even though it was encouragingly successful. When we entered the war, the apparatus was removed from that armored cruiser, and the work of installing catapults of a kindred character on other craft of the same type was discontinued. However, the subject was not forgotten, and as soon as peace was declared our naval aviation experts set about bringing the catapult to an up-to-date stage-profiting by the lessons learned during the conflict. More than once in the anxious years of that struggle, experience made it plain how very desirable it would be if seaplanes or heavy bombing aircraft could be dispatched from a mobile, floating base. The best that was done was to devise facilities which permitted rather short-range scouting 'planes to be sent aloft, under favoring conditions of wind and sea, from improvised platforms and mainly from stationary ships. These 'planes were not of a type sufficiently rugged to permit them to settle upon rough water and survive for any time

The U. S. S. "Wright," a seaplane tender and kite-balloon ship, as she appears during maneuvers with the Atlantic fleet.



The Chamber's catapult, ten years ago, with a hydroaeroplane in position ready for launching. The present seaplane catapult has evolved from this rather crude beginning.



Demonstrating the Chamber's catapult at the Navy Yard, Washington, D. C., in November, 1912. The launching car is dropping away from the aircraft just after leaving the runway tracks.

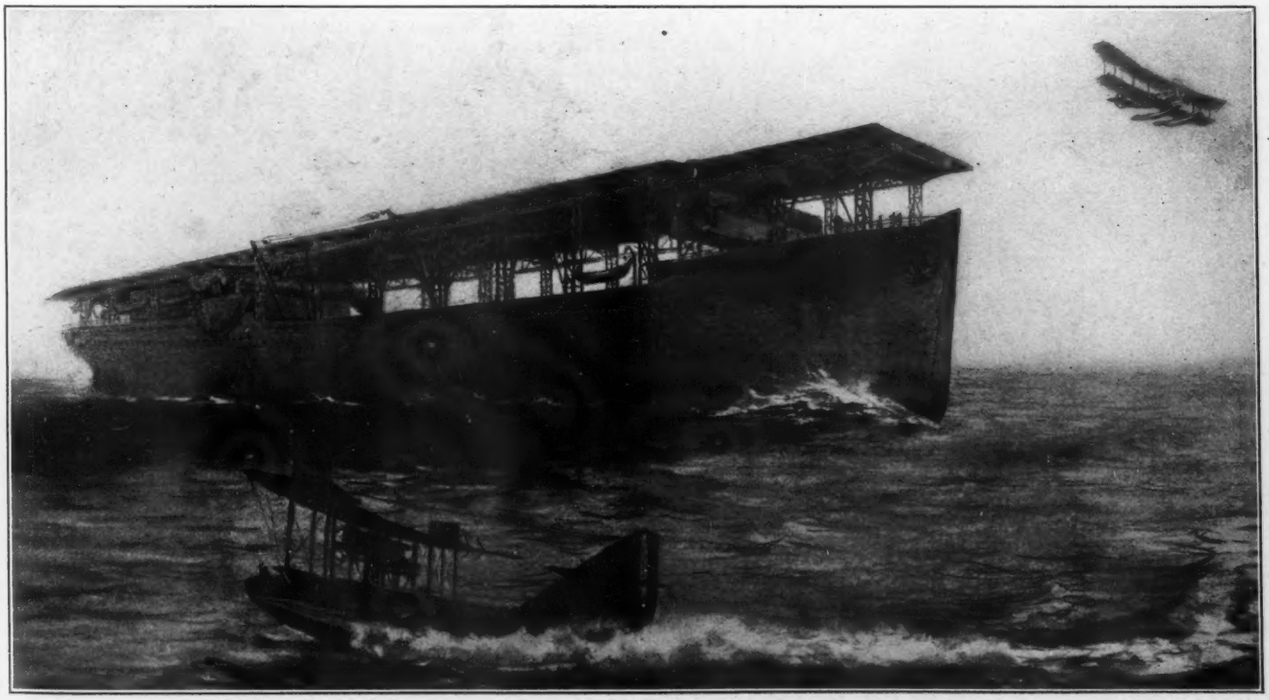
the smashing blows of even moderate waves.

During 1920-1921, the technicists of the aviation branch of the navy gave close study to the catapult, and as a result they planned an apparatus, about 50 feet in length, which could be mounted on a turntable and be swung easily in a horizontal plane. The catapult placed on the U. S. S. *North Carolina* was a rigid affair. The new device, when built, was set up on a barge in the Potomac River and subjected to a series of preliminary tests. One of these consisted of shooting from the catapult a mass of timbers, fastened together, weighing one ton and representing the dead weight of a seaplane. The trials showed the design to be satisfactory in every particular. This outfit was afterwards transferred to the great superdreadnought U. S. S. *Maryland,* and has been used repeatedly during the battle practice of the North Atlantic fleet.

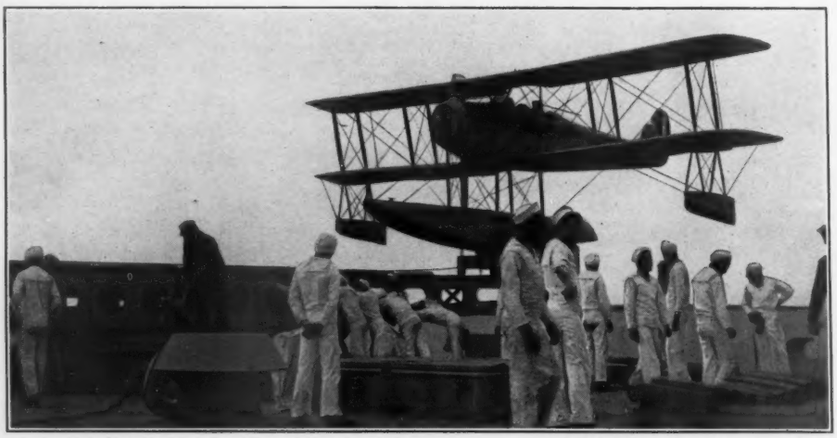
In its present form, the catapult is a permanent and not a demountable affair such as was placed aboard the U. S. S. *North Carolina.* Broadly, the apparatus is made up of a centrally pivoted, steel box-girder supported upon an annular foundation which forms the track on which the catapult swings in order to point the aircraft toward the wind or in the most favorable direction for launching. In the central part of the box-girder is housed the compressed air engine, and this engine is suitably connected by a manifolding purchase with the launching car, which runs along on top of the rotatable girder. This purchase is a steel-wire cable which extends from the engine outward to one end of the girder, thence over a sheave, and back above the track to the front of the car. The loading or "battery" position of the vehicle is at the rear or opposite end of the girder.

When the car, supporting a seaplane, is shoved to battery position, the truck is held in place by a releasing device, and before this is free to let go compressed air is turned into the operating cylinder of the catapult. This initial supply of air serves merely to move the piston far enough to take up any slack in the cable so that there will be no jerky motion when the car is swiftly drawn forward to effect the catapulting of the flying boat. In fact, the launching car is not released until the tow line has been properly tautened. When all is ready, the feed of air to the cylinder is increased gradually, the speed of the loaded car accelerating the while; and the pneumatic impulse is continued until the velocity is sufficient to give the aircraft inertia enough to keep it aloft until its engines, which are started just before launching, are able to meet the propulsive requirements. The launching speed at the instant the car automatically frees the flying machine is about 55 miles an hour.

At the climax of the acceleration, which is equal to approximately 1.5 gravity, the compressed air valve is closed; the car's grip on the seaplane is broken; and the brakes are progressively applied by which the launching truck is halted just before the end of the track is reached. At that point, the 'plane and the car part company, and the machine is projected into the air. The rolling carrier can be shoved quickly back to the loading station, and put



The U. S. S. "Langley," the latest addition to the Air Force of the Atlantic fleet. This is the navy's first out-and-out airplane carrier. The flying off deck is the long superposed platform. The ship is equipped besides with two compressed air catapults.



Official Photograph U. S. Navy.

Seaplane in battery position on the catapult, with engine running, in readiness for launching from the U. S. S. "Maryland."

"in battery" again in a few moments. The get-up of the catapult and its emplacement are such that the apparatus does not interfere with the firing of the big guns in the neighboring turret.

The purpose of equipping the U. S. S. *Maryland* with a catapult is to enable her to carry one or more aircraft so that she can protect herself from the attack of hostile flying machines. The seaplanes will also act as scouts or can be used for "spotting" the fall of her projectiles during target practice or in time of battle. It will be interesting to mention here that the navy's special airplane carrier, the U. S. S. *Langley*, is equipped with two catapults, one forward and one aft. This vessel will serve as a floating aviation field hangar and repair plant for the airplanes of the fighting fleet. As Rear Admiral W. A. Moffett, Chief of the Bureau of Aeronautics, has pointed out, the development of the airplane or seaplane catapult has put the United States Navy in the forefront so far as the employment of aircraft with the fighting fleet is concerned.

Unquestionably, the fact that heavy flying machines can thus be projected into the air from the deck of a battle craft and under any conditions that make flying possible is bound to alter profoundly naval tactics, and it is even suggested that a special type of airplane carrier may supplant the all-big-gun superdreadnought. This, of course, is looking ahead somewhat, but it may be worth while outlining some of the contributive factors of established value which may bring this about.

Seaplanes are available today which have a flying radius of 1,200 miles at a speed of 60 miles an hour. And modifications of these aircraft have been built which can carry bombs or automobile torpedoes weighing several thousand pounds. Flying machines of this description have demonstrated that they can transport a heavy load of these missiles or weapons to points 100 or more miles away from their bases, drop them or launch them, and then return to their starting points. At the present moment the maximum range of the most powerful guns mounted on battleships does not exceed 25,000 yards, that is, a trifle more than fourteen miles!

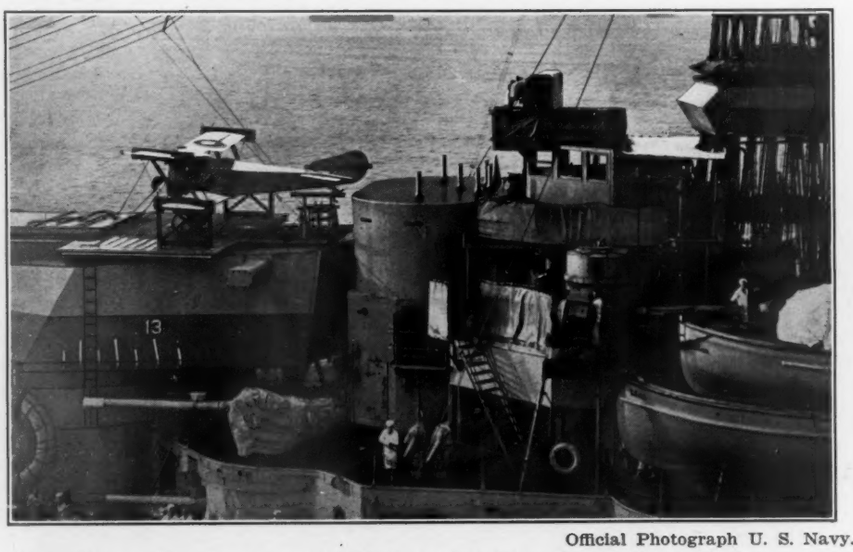
As has been well established, aircraft will be, henceforth, the eyes of the fleet; and for scouting purposes the air pilot is far more favorably circumstanced than the observer anywhere in the top of a surface vessel. Of course, the range of vision of the man high in the air varies according to the state of the atmosphere and the visibility of the ships on the water below him; but on numerous occasions airmen have been able to discern boats at sea 30 miles away, and they have discovered the smoke of large cities from a distance of 90 miles.

Even if the scouting aircraft does not possess effective powers of attack, still it may be the primary means of deciding a fight between battle squadrons. That is to say, the watchful airman may be able to give the range and the direction of the unseen foe and thus enable the big guns to be brought effectively into action long before the observers on the contending ships can spot the targets. During the World War, it was found of vital importance to open fire at the maximum range of the guns afloat, and the ship or fleet that "got the jump" on the enemy by first landing a damaging salvo was well-nigh without exception the victor.

Contrary to the general understanding, aircraft are not necessarily hampered from reaching their mark in the nighttime. In a recent article, which appeared in the Proceedings of the United States Naval Institute, Commander John P. Jackson made this statement: "Prior to the armistice, flares of 2,000 candle power, supported by 18-foot parachutes, were constructed which burned up to eleven minutes. Since then flares have been developed of 200,000 candle power capable of illuminating an area five miles in diameter and of making it as clear as day. The construction of flares of 1,000,000 candle power is planned. The parachute screens all space above it and reflects the light downward so that the 'planes can operate unseen in the gloom above while everything on the surface of the sea is clearly disclosed."

Experiments have revealed that the bomb, to be effective, must either score an actual hit or fall into the water only a few feet away from the side of the ship attacked. Further, it is well known that it is exceedingly difficult to plant a bomb from a flying craft, moving at a considerable height and speed, so that the missile will score. To lessen the chance of missing the mark and to attack a vessel where it is most vulnerable, Rear Admiral Bradley A. Fiske, U. S. N., invented the torpedoplane.

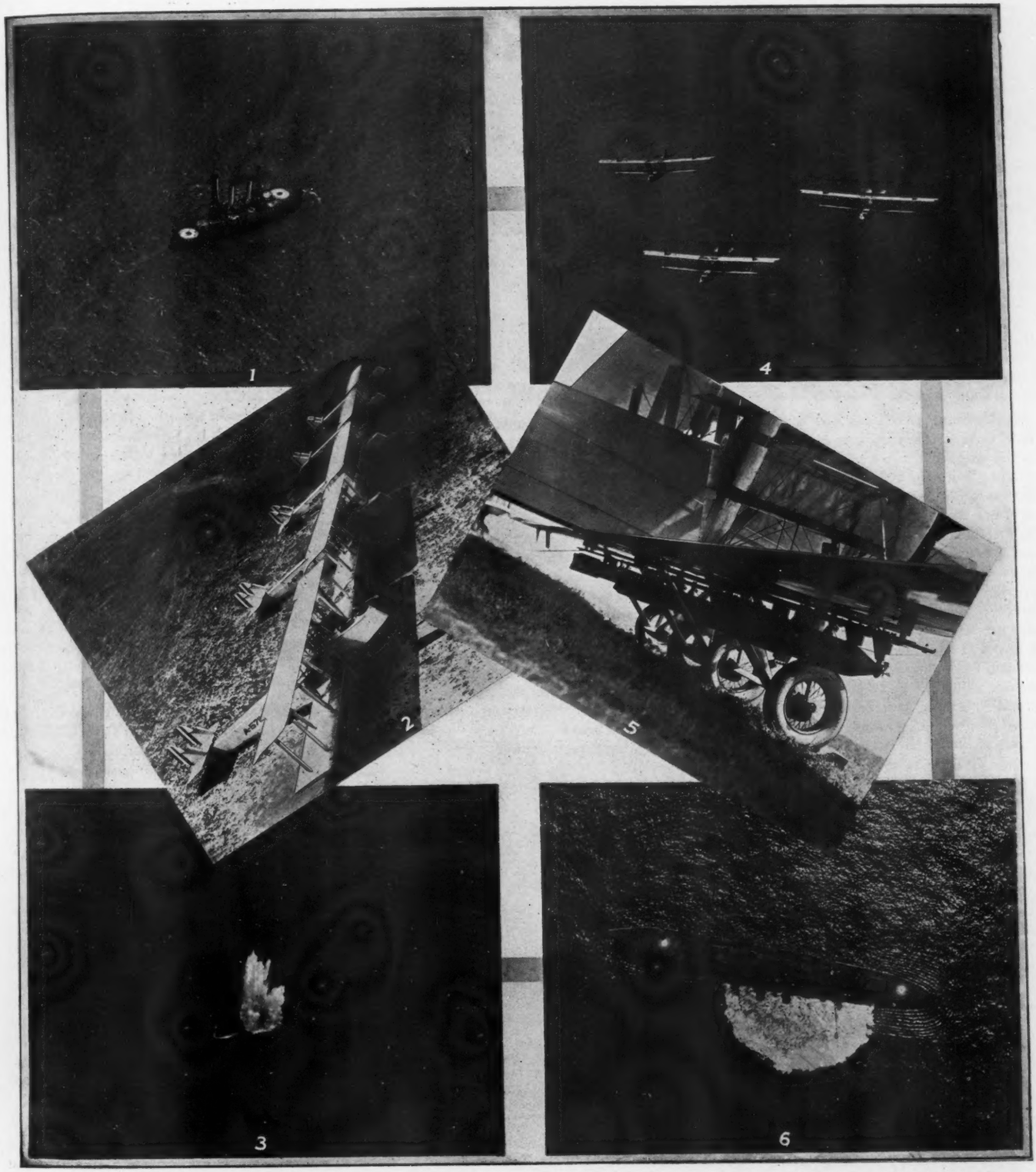
Ordinarily, the shell, the bomb, or the torpedo, when once started toward its mark, is beyond further human control. While the range of the torpedo has been increased to fully 10,000 yards, with an initial velocity of nearly 40 knots an hour, still an alert enemy can dodge the oncoming weapon owing to the fact that the torpedo betrays its line of advance by a plainly marked wake of seething bubbles. Therefore, to lessen this handicap, and to make it possibe to change the point of attack, the torpedoplane was conceived. This type of aircraft can carry one or more torpedoes—depending upon their size and weight, toward the enemy at a speed of 60 or more miles an hour and then aim and drop the missiles when near enough to the foe to give him little or no chance to swerve or dodge them, thus adding greatly to their deadly effectiveness.



Official Photograph U. S. Navy.

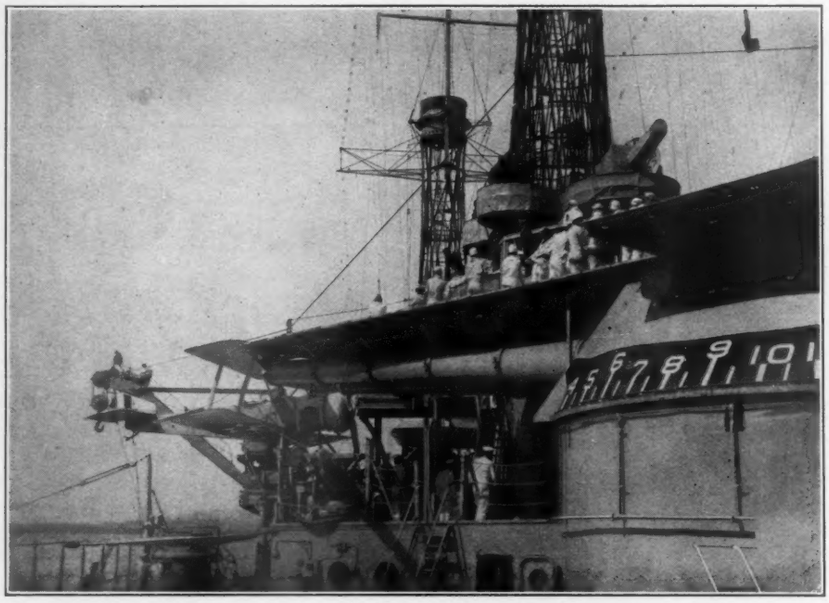
A small scout 'plane on a take-off platform aboard the U. S. S. "Mississippi." The flying machine attains sufficient momentum within the short run to project it into the air and to sustain it until its engine is able to give it the needful flying speed.

Bombing and Torpedoplanes in Mimic Conflict



Official Photographs U. S. Navy.

Fig. 1.—The radio-guided target battleship, the old U. S. S. "Iowa," which was used during the memorable bombing tests of 1921. Fig. 2.—A group of navy Martin bombers lined up preparatory to taking off for their bombing flight against floating targets, consisting of ex-German vessels. Fig. 3.—Scoring a hit. A bomb exploding in the water close alongside one of the target ships. Fig. 4.—U. S. Navy F5L bombers, in bombing formation, approaching the target ships off shore. Fig. 5.—A close-up of a Martin bomber showing the way in which the bombs are hung beneath the aircraft. Fig. 6.—Bombing the ex-German cruiser "Frankfurt." While the bomb did not hit the ship still the force of the explosion must have shaken her severely as indicated by the conforming wavelets extending outward from the bow and the stern.

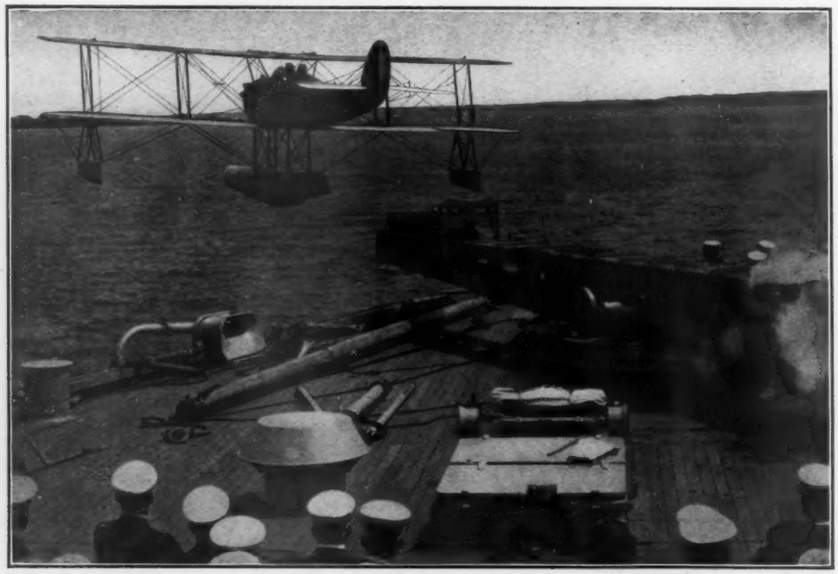


The take-off platform, mounted upon a turret, used in getting a small type of high-speed scouting machine into the air. This arrangement is now superseded by the pneumatic catapult.

Imagine the predicament of a squadron or fleet exposed to a swarm of titanic hornets in the shape of ten or a score of torpedoplanes! Circling and maneuvering as no flotilla of destroyers could hope to do, and at speeds twice as fast, the torpedoplanes would be reasonably certain to score disastrously, if peacetime battle practice is any indication of what might be expected during actual conflict. Further, Admiral Fiske has devised an apparatus, which he calls a "magnetic pistol," which would be able to detonate the high-explosive charge in a torpedo's warhead even if the missile passed beneath the bottom of a ship without coming in contact with the vessel's steel body. The mere proximity of the mass of ferrous metal would serve to bring the piston into action.

But the seaplane catapult promises to be an agency of more than military usefulness. As a matter of fact, it is likely to have a valuable field of application open to it in the operation of certain classes of merchant ships. Express steamers could not reasonably be expected to furnish deck room sufficient for the emplacement of long launching and alighting runways, and yet it would be highly desirable to have such vessels equipped with some type of apparatus by which seaplanes could be dispatched from them for the purpose of landing passengers and, possibly, postal matter while the liners were well off shore and speeding onward. The compressed air impelled catapult makes a service of this sort practicable; and because of its moderate weight and dimensions space could be found on most up-to-date ocean grey-hounds for an installation of this sort.

The foregoing paragraph seems to describe a one-way service, but such, in fact, is not contemplated if the aircraft catapult is adopted for ships of the merchant fleet. The seaplane of today is a fairly sturdy craft and fully capable of settling upon the open ocean even when a moderate sea is running; and big liners can readily be fitted with derricks, like those now found on fighting ships, which would facilitate lifting a flying machine aboard. Therefore, the aircraft can leave a shore base or port, overtake a steamer in the offing, alight upon the water, and be picked up from the sheltering or lee side of the momentarily halted liner. Such are some of the potentialities for which Captain Chambers blazed the way when he produced his air-driven catapult ten years ago.



Official Photograph U. S. Navy

The catapult in action. The seaplane just after it has been shot into the air.

COSTS OF DEEP MINING

WE OUTSIDERS—very far outside—are talking more or less wisely about the high temperatures encountered in operating at great depths in the earth, and of how those temperatures are to be dealt with. But the temperature problem is not the only one to be considered.

The Village Deep on the Rand, one of the deepest gold mines in the world, has a main shaft that has been sunk to a vertical depth of 6,263 feet—629 feet below sea level. The greatest difficulty here encountered is to deal effectively with the immense rock pressure. Big quantities of timber, which are required to secure the workings, add materially to the costs.

The *South African Mining and Engineering Journal* tells us that at the mine in question the cost for the "support of workings" is 1s. 7d. (more than 40 cents) for every ton of ore mined. The use of timbering seems almost absurdly inadequate for the purpose; and in our minds we can easily drive the workings to depths where steel only, and lots of it, would be effective. The hauling and the hoisting costs, of course, grow in increasing ratios with the depths, and, inevitably, the expense of operating becomes imperatively prohibitive.

TIDAL POWER INSTALLATION

WE have at last a definite promise of a practical attempt to develop mechanical power from the rise and fall of the tide. The French Chamber has passed a bill for the construction of an experimental tidal electric power station at Aber-Wrach, Finistère. This location was chosen because of the great difference in level between high and low tides.

The estuary is to be dammed, and four turbines will be installed and so arranged that they will develop power with equal efficiency when the water is flowing in either direction. Two alternators coupled to them will produce current at 1,500 volts. It is estimated that a maximum of 4,800 H. P. will be developed, but the mean production will be 1,600 H. P. The annual output in kilowatt-hours will be 11,000,000; and the cost will probably reach $1,500,000.

In extending their mail subsidy contract with the Castle Mail-Steamship Company, the Union of South Africa has made it a condition that additional refrigerating space be provided on the boats to carry fruits from South Africa to the United Kingdom and, furthermore, that the steamship line must transport South African beef to England at a lower rate than that charged for shipping Argentine beef to England.

A Big Excavation for Deep Rock Foundation

Pneumatic Drills, a Battery of Air Compressors, Four Steam Shovels, and a Fleet of 50 Motor Trucks Made the Rapid Prosecution of the Job Possible

By FRANK W. SKINNER

ADVANCED practice and the installation of an abundance of high-class equipment are features in the preparation of the site of the $7,000,000 building in the terminal district, of New York City, for the Equitable Life Insurance Company. The location, with a frontage of 200 feet on Seventh Avenue from 31st to 32nd Streets and a depth of about 275 feet, is adjacent to the great Pennsylvania Station and the Pennsylvania Hotel, where it is surrounded on three sides by heavy vehicular traffic that must not be obstructed during building operations. The structure will have a full-sized basement and two sub-basements which, extending to a depth of 50 feet below the street level, will support a 22-story superstructure above that elevation.

The south side of the site, until recently, was occupied by a few small buildings with shallow basements, and the remainder of the lot had been filled up to street level to provide parking space for automobiles. The rock surface slopes irregularly from an elevation of approximately ten feet below street level on the west side to about 30 feet below street level on the east side. The total excavation, of something like 100,000 cubic yards, consists of approximately 40,000 cubic yards of earth and 60,000 cubic yards of rock, which have been handled by a large compressed air and steam power installation.

After the removal of the old buildings, temporary sidewalks were laid on the three streets adjacent to the lot, derricks and air compressor plants were installed; and excavation was commenced by four steam shovels digging a north and south incline, extending nearly to the south side of the lot at a depth of about fifteen feet below the street, and then diverging eastward, removing all of the earth to a general elevation about fifteen feet below curb level. Other inclines, about fourteen feet in maximum depth and 28 feet in width, radiated in various directions until they covered the entire area and were carried down to the surface of the rock.

At night the lot was illuminated by eleven searchlights of 300 candle power each; and the shovels worked overtime, each averaging from 300 to 500 cubic yards of earth in an eight-hour shift. Most of the earth was delivered by the shovels directly to about 50 motor trucks, each of which was loaded in from two to five minutes. Where the shovels were not easily accessible to the trucks, the earth was loaded into steel skips, hoisted, and dumped into the trucks in the street. The work was carried on so efficiently that there was very little time lost by the trucks in waiting, and there was practically no time lost in moving the shovels.

The rocky sides of the excavation on the south and the west required no protection, but on the north the bank was steadied by sheet piling although it was very hard in places and would have stood alone if not exposed to heavy rain. Part of the protection consists of 30-foot lengths of 13-inch Lackawanna steel sheet piles which were driven with a 3,000-pound air hammer, at the rate of about 300 linear feet per day, by the Miller Daybill Company, subcontractor for shoring.

Title not having been secured for a strip of land near the middle of the north side of the lot, about twenty feet wide and projecting 60 feet into the lot, it was enclosed in advance of excavating by wooden sheet piles, driven until they took bearing on the surface of the rock from twenty to 30 feet below the street level. Two tiers of horizontal holes, twenty feet long, were jetted through this small enclosed strip of earth, and in them were placed rods with screw ends having nuts bearing on two tiers of walings that secured the sheet piling without obstructing the pit with exterior bracing.

Adjacent to the east side of the lot were two small brick buildings with a bowling alley, having a brick wall on the party line, between them. The foundations of the walls were of rubble masonry with earth bearings about twenty to 25 feet above the surface of the rock. The earth contiguous to these foundations was left undisturbed while the principal excavation in the lot was carried down alongside of them with a very steep face that stood well temporarily without sheeting. In order to safeguard the foundations they were underpinned with hollow steel piles, embedded in a solid sectional concrete wall, thus carrying the old structures down to the surface of the rock before the excavation was completed.

Several 4½x4½-foot pits, five feet deep, were excavated partly under the wall and sheeted with horizontal boards. In the bottoms of these pits, steel pipes, twelve inches in diameter, were driven to rock bearing by hydraulic jacks and interior excavation. The pipes were filled with concrete, wedged to bearing against the underside of the old footings, and the pits in which they were sunk were also filled with concrete having steel reinforcement bars embedded in it.

Afterwards the spaces between the piles were concreted, making a continuous girder, 122 feet long, from three to 4½ feet thick, and 13½ feet deep, in which the tops of the piles, supporting the full weight of the walls above them, were embedded. The lot excavation was then carried down to the bottom of this concrete girder; similar pits were sunk around each of the piles to a depth of eight feet; and the spaces were concreted for the purpose of underpinning the concrete girder and forming a continuation of the wall, thus allowing the excavation to be again resumed and carried down to the bottom of the wall, after which the process was repeated. In this way the concrete was made to reach down to the surface of the rock and permitted the excavation to be completed. The bottom of the concrete wall

An early stage in excavating for the foundation of a $7,000,000 structure.

"Jackhamer" drilling close to wall of a building during excavation on a foundation job.

was anchored securely to the rock by vertical steel dowels grouted into drill holes between the steel piles.

The soil under the old footings was very fine sand full of water, and the excavation for each horizontal section of underpinning was carried down until water was encountered. Then this portion was concreted. As the water level was lowered by drainage into the adjacent lot the excavation was again carried to the new water level, and another section of the underpinning wall was concreted. In this manner the excavation for underpinning was always in dry material and there was no danger of losing ground by pumping.

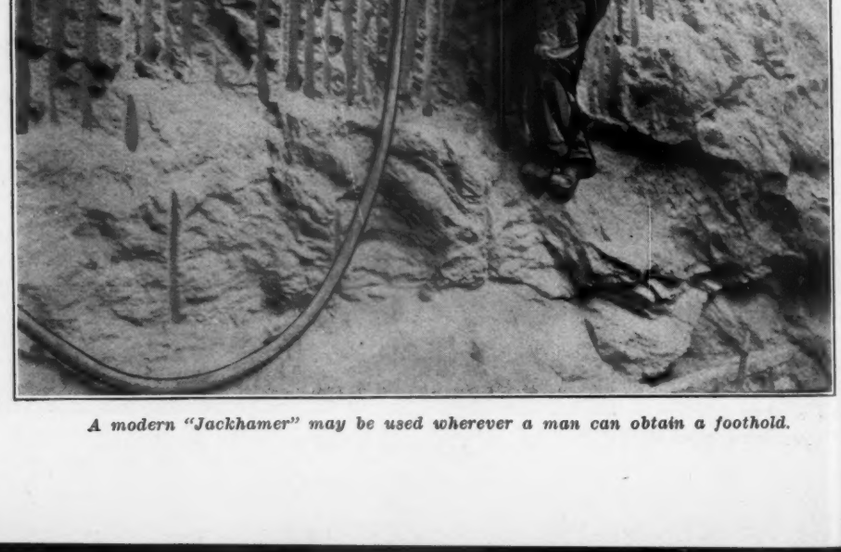
Although the underpinning did not at any time impair the stability of the buildings, they were additionally safeguarded by shoring with inclined wooden braces to the rock bottom of the excavation. Owing to the height of the buildings above the bottom of the pit, these braces were very long compound members made up of 12x12 and 12x16-inch timbers, having cross-sections of 12x28 inches, clamped together with steel yokes and bolts, lashed with wire cables, and tightened by pairs of wedges driven between them and the wood. The longest of these timbers was about 100 feet and was set at an angle of approximately 45°.

Rock excavation was commenced at the south side of the lot, where the rock was exposed, and was continued across to the north side as the surface was stripped by the steam shovel. For the excavation of the 60,000 cubic yards of rock there were installed four air compressors with capacities ranging from 450 to 650 cubic feet of air per minute. The compressors were placed at the street curb, in pairs, and each one was connected to a 4x10-foot receiver. Air, at a pressure of about 100 pounds, was delivered to the pit through 3-inch supply mains, and was used to operate fourteen "Jackhamers" with which holes were drilled two inches in diameter at the top and from two to ten feet deep.

The spacing and the depth of the holes varied greatly on account of the character of the rock which ranged from hard to soft, with many seams inclined at different angles, so that no uniform system of blasting could be followed. Steels up to twelve feet long were used, and holes were drilled to a maximum depth of about ten feet. They were charged with small amounts of 40 per cent. Du Pont dynamite, and were fired with great care to avoid any possibility of injuring pedestrians or property in the congested district.

The holes were always well covered with wire or rope mattresses and chained logs, and no accidents occurred although the shots were fired at all hours of the day and night. The rock was generally broken into comparatively small fragments and handled without block drilling, but some pieces had to be sledged so as to be able to lift them by hand. At first, most of the "Jackhamer" drills were concentrated at the highest point of the rocky ledge where the pit was carried down with a very jagged and approximately vertical face. Near the southeast corner of the lot the excavation was made deeper, practically forming a sump, about 40 feet in diameter, into which there was a considerable flow of water. This was removed by a Cameron pump that provided all the drainage required for the excavation, including surface water from rain. The drilling and the blasting followed as closely as possible after the earth excavation; averaged about 700 cubic yards of rock in sixteen hours; and was shattered by a force of 200 men using about 400 pounds of dynamite.

Most of the rock was loaded into 5-ton trucks by steam shovels, each of which handled from 35 to 45 truck loads per shift. The shovels could handle stones of from three-quarters to one cubic yard, but when the fragments were larger they were chained to the buckets and thus lifted. In the sump and in the deepest part of the excavation, which extended much below the level of the steam shovel ramp, the shattered rock was at first loaded by hand into about twenty 3½-yard steel skips handled by two stiff-leg derricks, with 60-foot booms, installed on timber towers on the south side of the lot. Another stiff-leg derrick and a large



A modern "Jackhamer" may be used wherever a man can obtain a foothold.

Care had to be taken in carrying the excavation downward to properly underpin and shore the foundations and the walls of adjacent buildings.

guy derrick were erected near the east side of the lot, and were used to handle plant equipment, materials, and the earth and rock when the latter was not loaded directly by the steam shovels. The hoisting engines operating the derricks and the air compressors were driven by electric motors supplied with current from commercial mains in the street.

Eventually, the operation of the trucks over the entrance ramps was discontinued; two of the steam shovels were removed; and the other two were installed in the sump, which was gradually enlarged to extend over the whole lot area. The excavation was completed by bringing the entire bottom of the sump to subgrade and by trimming down the sides of the pit. The last 30,000 cubic yards of rock was delivered by the derricks to trucks in the street, about 75 per cent. of it being loaded by hand into skips.

The excavation was made by the Thomas Crimmins Contracting Company, J. H. Ross, superintendent. The Thompson-Starrett Company is the general contractor; Miller, Daybill & Company was in charge of shoring and sheet pile driving; and the Underpinning & Foundation Company handled the underpinning.

Freight rates on wrought iron and steel compressed air cylinders from Pacific coast points to eastern territory have been cut, according to an announcement by the Southern Pacific Company. The reduction took effect January 12 of the current year.

Under the government subsidy plan for making use of the national fuel resources, Italy is considering the extensive development of steam-electric power through the utilization of its lignite deposits.

HOW MUCH POWER DOES A BEARING ABSORB?

(Copyrighted by W. F. Schaphorst.)

BY LAYING a straightedge across the accompanying chart three times, as indicated by the dotted lines, it will give the horse power consumed by any bearing, coefficients of friction varying from .0006 to 0.6; shaft diameters from 0.1 to 10 inches; R.P.M. from 100 to 10,000; and the load on the bearing from 10 to 10,000 pounds.

For example, using a coefficient of friction of .02 (column A), which is average practice; a shaft diameter of two inches (column C); a speed of 2,000 R.P.M. (column E), and a 400-pound load on the bearing (column G), column D gives the friction horse power as a little over 0.25.

Connect the known value in column A with tions (columns B and F), and the intersection with column B. In the same way connect columns E and G, and locate the intersection with column F. Lastly, connect the intersections (column B and F), and the intersection with column D gives the friction horse power of the bearing. Column A gives an idea as to coefficients met with in every-day practice, beginning with the very best conditions and ending with starting friction.

Coefficients of friction under the many possible conditions are given in text books, in Alfords' "Bearings," and in such handbooks as "Kent" and Lionel S. Marks' new "Mechanical Engineer's Handbook."

Only the general safe values of practice are designated on this chart. The principal function of the chart is to quicken the making of computations for anybody who has to do with bearings.

The chart, of course, can be used backwards as well as forwards. For example, if the power absorption by a given bearing is known, and if values in columns C, E, and G are known, the coefficient of friction is quickly determinable.

Then, knowing the coefficient of friction with a given oil and in a given bearing, the power required by a similar bearing of different diameter, speed, and loading may be found with an accuracy sufficient for most practice.

The chart explains many things—teaches many lessons. For example, for belt transmission practice it tells us to run belts with as little tension as possible; to run shafts at low speeds if possible; to use small shafts, preferably; and to keep the bearings well oiled, with the proper oil, and in good condition.

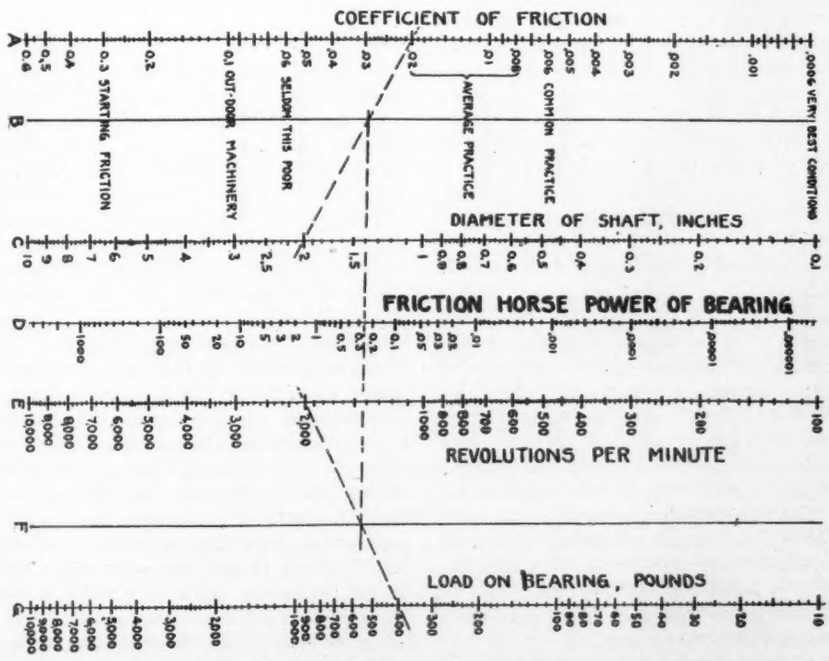


Chart from which the power absorption of a bearing may be determined.

Compressed Air Magazine

—*Founded* 1896—

Devoted to the mechanical arts in general, especially to all useful applications of compressed air and to everything pneumatic.

Business and Editorial Offices:
Bowling Green Building, No. 11, Broadway, New York City. Tel. Bowling Green, 8430

Publication Office: Somerville, New Jersey

TERMS OF SUBSCRIPTION

$3 a year, U. S. A., American possessions and Mexico; all other countries, $3.50 a year, postage prepaid. Single copies, 35 cents. Back issues more than six months old, 75 cents each.

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EDITORIALS

THE SCIENTIFIC MIXING OF CONCRETE

MOST engineers are familiar with the fact that the volume occupied by a given amount of sand, when shoveled into a measuring receptacle, varies with the moisture content. This variation, in the case of moist sand, is usually from 10 to 15 per cent., reaching as high as from 40 to 50 per cent. when the sand is very wet. This has often led to unsatisfactory results in mixing concrete by the generally specified formula of so many parts of cement, sand, and gravel—the amount of sand thus finding its way into the mix being quite different from the quantity actually desired. The outcome then is a batch that is either too strong or too weak.

The engineers of the United States Bureau of Standards have worked out a new method whereby the sand may be more accurately measured. By its application they hope greatly to improve the character and the reliability of concrete construction which, they claim, has fallen down in many notable instances. The scheme they suggest, and which they have been working on, is called the "inundation method." It consists of measuring the sand in a container first filled with just enough water so that after the sand is put in and completely soaked the water will be level with the top. By this procedure it is found that uniform results may be obtained no matter how much the original moisture content may have varied.

In mixing concrete, the proportions of cement, sand, stone, and water are so chosen as to give the required strength and workability with a minimum amount of cement. Cement is, of course, the principal item of cost in the mix; but "rich" concrete is not necessarily stronger than the concrete made of sand that has more water in it than is called for by reason of the moisture already contained in it. If allowance is not made for the moisture content of the sand, in other words, if the amount of water added does not vary accordingly, then the concrete will be much too wet and, when set, will not be dense enough to assure the necessary strength.

The engineers of the Bureau of Standards hope that by their inundation method it may be possible to specify concrete in terms of strength rather than by the usual plan of arbitrary proportions. The contractor can then use his materials in such quantities that the resultant concrete will have the desired characteristics. In substance, concrete may be prepared which will meet requirements with a certainty that is not now possible without adhering to, perhaps, an unnecessarily high factor of safety. That is, the standardized, scientific mix will give the desired strength with a minimum use of cement and, therefore, permit substantial economies.

LIQUID OXYGEN EXPLOSIVES NO LONGER EXPERIMENTAL

NEARLY two years ago we reviewed in our news columns the potentialities of liquid-oxygen explosives. At that time we pointed out especially what had been done in this field by the hard-pressed Germans, who were for some years cut off from a supply of Chile saltpeter, so widely used in the manufacture of various modern high explosives.

It will be recalled that the Teutons, harking back to efforts made to use liquid air for blasting purposes in a Bavarian coal mine about 1897 and to tests of "oxyliquit" which were made two years later during the driving of the famous Simplon Tunnel, realized that those pioneer essays, although abruptly halted, offered a possible solution to one of their grave problems and, therefore, they took up again the long-abandoned work and tried to develop liquid-oxygen explosives for military purposes.

As the world learned after the cessation of the European war, the Germans achieved some success in their quest and actually employed explosives of this kind in certain iron mines and in effecting the destruction of the great French steel mills at Longwy. The results attained answered for the moment; but the system of manufacture and the explosives, themselves, were in a measure crude and not to be gaged by commercial standards.

The activities of the Germans in this matter served to stimulate the inventive cunning of the renowned French physicist, Dr. GEORGES CLAUDE, long intimately identified with researches in the liquefaction of gases. During the closing years of the recent conflict, and since then, Doctor CLAUDE has done wonders in advancing this particular art and in devising a manufacturing process that would place liquid-oxygen explosives on a par with the usual nitrogenous explosives. Not only that, but he has proved that this can be done at a cost which makes the adoption of these safe explosives practicable in the mining and in the quarrying industries and for excavational undertakings where explosives must be used.

Because of our past interest in this important subject, we are pleased to be able now to announce that Doctor CLAUDE's epoch-making researches are to bear fruit in the United States. The Air Reduction Company, which stands at the forefront in America in the liquefaction and the manufacture of gases—especially oxygen and nitrogen, has taken over the CLAUDE process. This well-known concern has further developed the process and has brought it to a stage of great efficiency and commercial practicability. The Ingersoll-Rand Company, the leading manufacturer in the world of all sorts of compressors and for 50 years conspicuously linked with the mining industry, has become associated with the Air Reduction Company for the purpose of producing and of selling equipment for the maknig of liquid-oxygen explosives.

While these two companies are not at the moment ready to enter the general market, owing to their desire first to thoroughly organize a force of experts that will be able to deal properly and promptly with the business that is certain to offer, still they will soon assemble their initial liquid-oxygen explosive plant at the mines of the Witherbee, Sherman Company, Mineville, N. Y. The installation will be capable of producing hourly fully 75 liters of liquid oxygen; and it will be unusual in that it will be located underground.

Because of its size and what the plant represents in the way of an innovation, the equipment at Mineville will unquestionably command wide attention not only in mining circles but among men in many departments of engineering.

IMMIGRATION

IT IS generally agreed that our present immigration laws are not only ineffective and incompetent, but that they are stupid as well. America, the greatest industrial country in the world, is handicapped in consequence in its efforts to compete with the world, because we, as a nation, cannot get enough common labor.

Who wants to encourage people to do common labor? Who wants to do common labor? Only those who are accustomed to a low standard of living; those who have not had the advantages of education; those without vocational training, people who must work to live. Naturally, this class is not a large one in the United States

Everyone wants to rise in life. Here the son of a laborer very properly aspires and ofttimes becomes a mechanic or a clerk, so that we are forced to depend upon Europe, where the standards of living are lower, for our quota of common labor. Yet the restrictive 3-per cent. immigration law stands in the way and makes it necessary for us to bid up for common labor—paying prices in places that are higher than those paid for some kinds of skilled labor.

Mr. W. R. INGALLS, consulting engineer and economist, in an address delivered at the Chemists' Club in New York, recently set forth some very wise principles on this subject. To begin with, he advocates that we register all of the 8,000,000 aliens now in this country as well as the newcomers, and then keep track of them;

next, that we exclude the unhealthy, the infirm, the criminal, and the classes that we do not need, especially those that tend to crowd themselves in big cities; and, finally, that we exercise control over immigration in the countries and at the ports of emigration. With such restrictions and such control Mr. INGALLS recommends letting immigration be quite free.

Last, but not least, this eminent engineer urges that it be made impossible for any man to acquire American citizenship until he has proved himself fitted for it.

RUBBER LATEX

UNTIL recently, all crude rubber from the Eastern plantations—the source of nine-tenths of the supply—reached the consuming countries, in the shape of the well-known smoked sheets, crêpe, etc. These sheets are manufactured at the plantations, to suit commercial requirements, by coagulating the milky rubber latex in various ways as it comes from the tree.

Latterly, however, considerable quantities of the latex, treated with a small amount of ammonia to prevent coagulation in transit, have been exported; and all sorts of experiments are being made with this new form of the raw product. Some of these bid fair to revolutionize older methods of manufacture. The stimulated activity in the importation of rubber latex has been brought about chiefly by reason of discoveries made by British chemists which show that the material is valuable in certain paper-making processes—a branch of industry in which rubber has never figured before.

Practical commercial experiments in paper mills, says the *India Rubber World*, have shown that all grades of paper can be improved in some respect by the use of rubber latex. These investigations have been conducted in many mills in the United States, England, Scotland, Canada, Belgium, France, Spain, and Norway. Other countries are expected to follow suit, as they have already placed their order for the latter.

The world's output of paper is about 14,000,000 tons a year, valued at approximately $1,500,000,000. When the rubber interests join hands with such a big industry it is to be expected that, aside from the benefits that will accrue to both, immense possibilities, as yet unsuspected, will be opened up.

Another use of rubber latex is found in the rubberizing of threads and yarns before they are woven into fabric. The older method of rubberizing fabrics was to impregnate the cloth, after it had been woven, with the rubber mixture by passing the fabric with the rubber through a system of calender rolls. It has now been shown that much better results are obtainable by rubberizing the threads, before weaving, with properly treated latex. It has also been found that threads can be much more thoroughly impregnated with rubber by this method, and that their strength and durability are thereby greatly increased. This applies to all classes of rubberized fabrics, and is expected to be particularly advantageous in the case of tire fabrics—indeed, it is predicted in some quarters that it may bring about a revolution in tire manufacture equal to that caused by the introduction of the cord tire.

Most of the men that have been experimenting with rubber latex are loath to say very much about the results they have secured. The United States Rubber Company has been the largest importer of rubber latex and has, perhaps, given the subject of its use most attention. Be this as it may, enough information is slowly leaking out from the company in question and other large tire manufacturers and paper mills to stimulate a great general interest in the work that is being done, and all because it is now possible to provide crude rubber in a new form.

RAILWAY BROTHERHOODS AS BANKERS AND MANUFACTURERS

IS LABOR'S entry into the field of capital going to hasten the settlement of those differences which have so long existed between these two great economic forces?

We have for many decades been accustomed to look upon the capitalist as the man who puts up the money from which is paid the wage of the man who works and produces the material things essential to the comfort, the convenience, and the progress of social life. But recent happenings reveal a turning of this time-old tide; and the worker, profiting by his experience as a producer, is now bent upon entering the ranks of the manufacturer and the banker. And, what is much to the point, the primary purpose is to promote the very services or the occupational activities upon which depend the welfare of the particular classes of labor concerned and the interests of a vast share of the public at large.

It will be recalled that the Brotherhood of Locomotive Engineers lately purchased stock in a well-known trust company and promptly elected its chief officer to the directorate of the trust company in question. This was a significant move on the part of a union numbering 90,000 members. Within the past two years this same Brotherhood took its first step into the realm of high finance. In the interval it has established ten coöperative banks, which represent resources totaling $19,000,000.

As has been well said by one of the men identified with this movement: "The theory that banking is a powerful factor in the field of economics has always been emphasized by leaders of capital. So, it would seem, labor and capital have come to a complete mutual understanding on the subject of banking."

This tendency is further indicated by the course taken by WILLIAM G. LEE, president of the Brotherhood of Railway Trainmen, who has accepted the presidency of a $10,000,000 manufacturing concern in Indiana. This corporation is to engage in turning out automatic train-control devices which are capable of bringing a train to a halt whenever anything goes wrong. The apparatus are designed to operate by compressed air, and are of such a nature that some of the features are attached to the locomotive and others to the roadbed. In explaining his action, Mr. LEE has said: "My only reason for taking the position is the service I believe I can render railroad employees and the traveling public in a real safety-first movement."

CONFIDENCE

THE FOUNDATION upon which the structure of society is built is as old as society itself. This foundation is confidence. Customs, manners, and usages may change with the centuries, but confidence must endure lest the superstructure tumble. The world views differently from generation to generation the life and the interrelations of men, and draws different conclusions. Laws change as conditions change, and methods of life are constantly changing.

Man of today is born with the same instincts, with the same nature as man of a thousand years ago. He has, however, learned to restrain his instincts; to treat his fellows with more respect and consideration; to have confidence in his neighbor; and not to look upon society as a natural enemy.

Society has recognized that it is to its best interests to treat its members fairly and honestly. Confidence begets confidence, just as suspicion and distrust beget like attitudes. Society has discovered that confidence is the basis on which its actions must rest—that "a man who is poor in trust is the poorest of God's creatures."

Confidence is a state of mind or a firm belief in the trustworthiness of others. It manifests itself in our actions; in our behavior towards one another; and in the most common and homely affairs of every day. A man has confidence in his doctor, his lawyer, his banker; and this confidence is an expression of the development of human nature brought about by education and necessity.

Think of the confidence we display daily, many times a day in fact in our ordinary routine life. Entering the subway, the elevated, or the trains that carry millions of us every 24 hours, we place ourselves at the mercy of many people, and we put ourselves entirely in the hands of the motorman or the engineer. In part, our safety depends on the men who rolled the rails over which we ride; on those who made the wheels, axles, the cars; and, again, on others who designed and erected the bridges over which we go so serenely.

It has probably never occurred to us to doubt the sincerity of those workers who contribute to our convenience, who have made it possible for us to travel so comfortably, so speedily, and so safely. They are merely cogs in the great cycle of evolution; but we have confidence in them, and they seldom betray our confidence. By an educational process, slow of development, society has come to regard these everyday matters as a part of its fundamental structure—ethical principle and self-interest combining to make them so.

There will always be pessimists as there always have been. They will tell you that the world has not changed for the better, and that there is no more honesty today than in the time of ALEXANDER, CHARLEMAGNE, or NAPOLEON. These are the people who contend that every man has his price—who are always "from Missouri." Having no confidence in themselves, they have none in any one or any thing. They overlook the fact that the civilizing influences of Christianity and of education have remade and are constantly remaking man.

RECOVERING VALUABLE POWDERS BY THE ATOMIZER

THE atomizer is now doing the work formerly expected of the filter, doing it much more completely, and with incomparably greater rapidity. In short, it is recovering values from hitherto waste liquids of various manufacturing processes.

Walter H. Dickerson, in a recent paper before the New York Section of the American Chemical Society, describes the process and apparatus which produce matter, in the form of a dry powder, from the liquids treated. The liquid, while in the spray, is exposed to heated air or gas which quickly evaporates the moisture and leaves the dry powder.

In the manufacture of paper, only about 50 per cent. of the wood pulp goes into the paper. The waste waters contain high percentages of lignin, the adhesive material of the wood which is not required in the paper but which is valuable as a binder in cores for the foundry and for coal briquettes. These uses make its recovery profitable.

The waste waters from fish-oil plants yield fertilizers and poultry food; and from wool cleansing establishments are obtained grease, nitrogen, and potash. Starch can be reduced to a fine powder by the atomizer and drier and cheaper and quicker than by the old methods. Wastes from the sugar mills of Cuba are made into stock foods; and the pineapple juices from the canning factories of Hawaii are no longer discharged into the ocean but are, instead, converted into fine sugar.

The spray drying process has improved the method of producing powdered milk. Heretofore it had been difficult to control the temperature, with the result that the milk sometimes had a burnt or a "caramel" taste. This has now been entirely overcome by use of the atomizer.

TECHNICAL INSTRUCTION BY MOTION PICTURES

AN extensive lecture course on industrial processes is offered for the first time by the School of Commerce of New York University. The subject matter is presented entirely by means of motion pictures, with just sufficient information supplied by the lecturer. It is believed to be the first course of its kind in which moving pictures are used well-nigh exclusively.

The students are shown many of the more usual machines, operations, and assembling methods in modern industry. Starting with the basic industries, such as coal and iron mining and steel making, the course presents, in detail, the various stages through which the raw materials pass until they are converted into the finished products.

One of the pictures, for instance, tells the story of the building of a locomotive, and begins right at the iron mine. It follows on through the blast furnace, the steel mill, the forge, and the foundry, until the locomotive shop is reached, where machining and assembling operations are illustrated in detail. Finally the finished engine is seen ready for its trial run.

SAMPLING AND ANALYSIS OF COAL, COKE, AND BY-PRODUCTS. A book of 184 pages with illustrations and tables, Price $3.00. Published by The Carnegie Steel Company, Bureau of Instruction, Pittsburgh, Pa.

ALTHOUGH the present work, covering as it does the methods of the chemists of the United States Steel Corporation, is apparently a second edition of an earlier brochure, it is really little less than an entirely new work. Not only has all the old material been carefully reedited and revised so as to bring the methods up to date, but a great many methods and tests not dealt with in the former work are now described. The amount of these additions is indicated by the fact that the current volume is double the size of its predecessor.

This book should be in the hands of any one at all interested in this field of investigation.

A HISTORY OF COMMERCE, by Clive Day, Ph.D., Knox Professor of Political Economy, Yale University. A volume of 676 pages with maps and charts. Price $2.50. Published by Longmans, Green, & Company, New York.

THE first edition of this work appeared in 1917, and the reason for the current edition is thus explained by the author: "The year 1914 marks one of the great turning points in history. I have accordingly revised the part of this book covering the recent period to close the narrative at that date, and have added another part, covering the history of commerce in the war and in the two or three years of peace immediately following. The commerce of the great nations of the world has departed since 1914 far from its accustomed paths and forms. In my attempt to make intelligible the commercial changes of the time I have had to take account of matters in public finance, currency, and foreign exchange which are usually treated apart from the history of international trade. I have thought it better, by touching on these outside subjects, to show the reasons for the course which commerce has followed, rather than to omit the reasons because they are hard for the student of the history of commerce to understand."

A LIBRARY OF ENGINEERING POINTERS, a series of 52 booklets, published weekly by Power, Tenth Avenue & 36th Street, New York, N. Y. Subscription price, $3.00 yearly.

LAST August, the editor of Power called the members of his staff into his office and said: "Boys, I want you to do something for power-plant men that has never before been attempted. I want you to try your hand at a series of booklets that will contain a complete, up-to-date, readily understandable digest of all the facts that will help engineers to handle the various problems that come up in their work. Each booklet must cover one subject and only one."

Since then, nine of these little volumes have been written and printed, and a limited number of them is now available for distribution. The titles of these tabloid treatments of important engineering topics are: Two Hundred Power Plant Pointers; Two Hundred Diesel Engine Pointers; Pocket Pointers for the Electrical Man; Fuel Oil Pointers; Steam Turbine Pointers; The A. B. C. of Combustion; Lubrication Pointers; Valve Setting; and Refrigeration Pointers.

The publishers have done something well worth while, and these booklets should prove very helpful to many men in many directions in our industrial life.

THE BOOK OF BUSINESS ETIQUETTE, an anonymous work of 293 pages, price $2.00. Published by Doubleday, Page & Company, Garden City, N. Y.

THE reason for this volume is very well expressed in the opening words of the second chapter, to wit: "Every progressive business man will agree with the successful Western manufacturer who says that 'Courtesy can pay larger dividends in proportion to the effort expended than any other of the many human characteristics which might be classed as Instruments of Accomplishment.'"

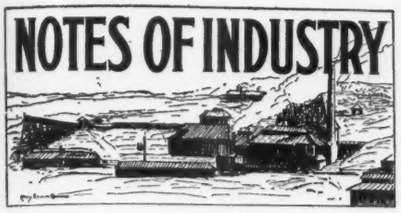
The author has presented the need of courtesy in business relations in a very readable and attractive manner, and has cleverly made apparent just what can be gained by a continual display of decent manners. Most of us can learn something from the book even though we may be pretty well satisfied with our general performance in this field of intercourse.

AMERICAN MACHINIST GEAR BOOK, by Charles H. Logue and Reginald Trautschold. Third edition, 353 pages, with numerous illustrations and tables. Price $2.50. Published by McGraw-Hill Book Company, Inc., New York.

THIS book appeared originally in 1910, and promptly proved its worth owing to the steadily increasing demand for more general knowledge of gears for the transmission of power. The continual development of the automobile, with its well-nigh universal dependence upon driving gears, has added still more to the desire for information regarding this phase of practical mechanics. The present edition of Logue's initial volume has been thoroughly revised by Trautschold to bring it up to date, and this work has been done ably and in a way to add very materially to the value of the book as a source of reference and as a guide to the man in the shop, the man at the drawing table, and to the mechanical engineer generally.

CONSTANT BUBBLES

The air bubble in spirit levels, used in surveying instruments, varies quite appreciably in length with changes of temperature, the changes affecting the minute accuracy of the observations. It is stated that the difficulty has been entirely overcome in a new type of level, with a "constant bubble," produced by E. R. Watts & Son, Limited, an English firm. It depends upon the exact relative proportions of air and spirit. The cross-section of the tube containing the liquid is of such shape that as the temperature is raised and the surface tension is decreased only the cross-sectional area of the bubble is affected, while its length remains unaltered.



The loss by evaporation of oil in open storage tanks is quite a serious matter, as the most valuable constituents of the oil evaporate, and the volume is considerable. This evaporation is now reduced at least 75 per cent. by topping the surface of the oil with a thin film of a liquid compound of glycerin, glucose, and glue. This coating completely covers the oil and effectually reduces evaporation.

Thousands of date palms in Lower California, set out by the Jesuit missionaries in 1720, are still producing quantities of high-class fruit.

An announcement has been made by the Secretary of the National Foreign Trade Council that the meeting of the Tenth National Foreign Trade Convention at New Orleans has been postponed from April to May 2, 3, and 4, 1923.

The American Consul at Quebec, Canada, reports that 82,301 United States automobiles passed through that picturesque old French capital in 1922, just 40,344 cars more than the year previously. The Province of Quebec is actively engaged in improving its roads so as to attract a still greater number of motor tourists.

Proposed hydro-electric developments in New Zealand are to involve a total expenditure of more than $60,000,000. The undertakings are to be spread over a period of ten years, and are to reach a maximum outlay of $10,000,000 in 1925.

Since the conquest of Algeria by the French, in 1830, seven important dams have been constructed there. Five of these are in the western department of Oran, and the remaining two in the central state of Algiers. The largest reservoir, created by the dam at Habra, now contains about 25,000,000 cubic meters of water and irrigates about 90,000 acres of land. In the plains of Cheliff, where crops are not infrequently ruined by droughts, there are two dams capable of irrigating about 15,000 acres. The government plans a number of large extensions to this system, for which purpose 202,000,000 francs have been voted.

Activity has been resumed at the tin works at Nampaton, French Indo-China, and it is announced that the new plant in course of construction there will handle 200 tons of ore a day, producing 2½ tons of pure tin. The deposits of tin in Laos are considered the richest in the world.

The deepest producing oil well in the world, and also the deepest well ever drilled by a rotary outfit, is Kishi-Lang No. 4 at Orange, Tex. It is 5,490 feet deep and is flowing 100 barrels a day.

Six fog signals at Manistique, Sheboygan, Frankfort, Manitowoc, Kewaunee, and Point Betsie, in the Twelfth Lighthouse District, Lake Michigan, are now operated by electrically driven air compressors. The stations in commission have proved so satisfactory both from a mechanical and an economical point of view that three other fog signals in the same district are being similarly equipped.

Of the 4,000,000 pairs of shoes used in Mexico annually, three-quarters are manufactured in the republic while the remaining 1,000,000 pairs are imported from the United States.

The great mineral belt of Mexico has produced one-third of the silver now existing in the world.

Realizing the possibilities of an export fruit industry through the world-wide movement towards the upbuilding of fleets of refrigerator ships, the Republic of Ecuador has recently passed a law authorizing the president to grant special privileges and concessions to those who undertake the planting of fruit orchards in that country.

A useful by-product, in the form of sludge, is obtained from the carbide employed in oxy-acetylene welding. This residue makes an excellent whitewash, and is thus put to practical use in many shops. The product obtained from the carbide sludge has been found to be even superior to the regular lime wash because it seems to have better sticking qualities. For that reason it is especially well adapted for whitewashing pits, etc., where the surfaces are apt to be damp. The sludge is mixed with water and then applied by means of the compressed air spray.

Press reports advise us that Germany keeps 33 printing plants and twelve paper mills busy to supply the daily demand of 45,000,000,000 marks. The introduction of 50,000-mark notes is expected to increase the output to 60,000,000,000 marks. It is not unlikely that the need for notes of still higher denominations will shortly double this figure! Aside from what these activities will lead to, here, at least, are two German industries that are working over time.

Ammonia dynamite is the most common explosive used in quarry work, so we are told by Oliver Bowles, mineral technologist of the Bureau of Mines. In wet holes, gelatin dynamite should be employed. For lime-kiln operations, explosives with a high rate of detonation should not be generally resorted to inasmuch as they have a tendency to shatter the rock into small pieces that are not used in lime burning except in the rotary kiln. Dynamite of 30 to 40 per cent. strength is most satisfactory. For seamy rocks some operators advocate black blasting powder, which will penetrate the seams and push out the rock masses with comparatively little shattering.

There are over 17,000 moving picture houses in the United States.

LARGEST FLOATING DRY DOCK

A FLOATING dry dock, bigger than any now in existence, is to be constructed at Southampton, England. It will be capable of taking in the largest vessels in the world, say the *Majestic* or the *Leviathan,* or bigger ships that may be built. It will be 960 feet long—this dimension not limiting the length of craft to be accommodated, 134 feet in width of opening, and have a lifting capacity of 60,000 tons.

Fourteen motor-driven centrifugal pumps, with a total capacity of 20,000 tons of water per hour, will be installed. A maximum of 80,000 tons of water will need to be ejected, and it will take four hours to accomplish this. Electric current will be supplied from the shore. The dock will be equipped with many other appliances, including air compressors for pneumatic tools, pumps for fire service, electric capstans for warping and hauling, and traveling cranes for handling material and equipment.

NON-MAGNETIC IRON

IT would seem to be one of the most remarkable coincidences of which we have record, that the production of non-magnetic iron should be simultaneous, as years go, with that of iron defying rust and stain. The latter is rapidly coming into use in various branches of manufacture. We have a practically complete line of stainless steel cutlery; precise measuring scales for fine machine work are appearing; and the metal is being employed for making valves and other important parts of operating machinery.

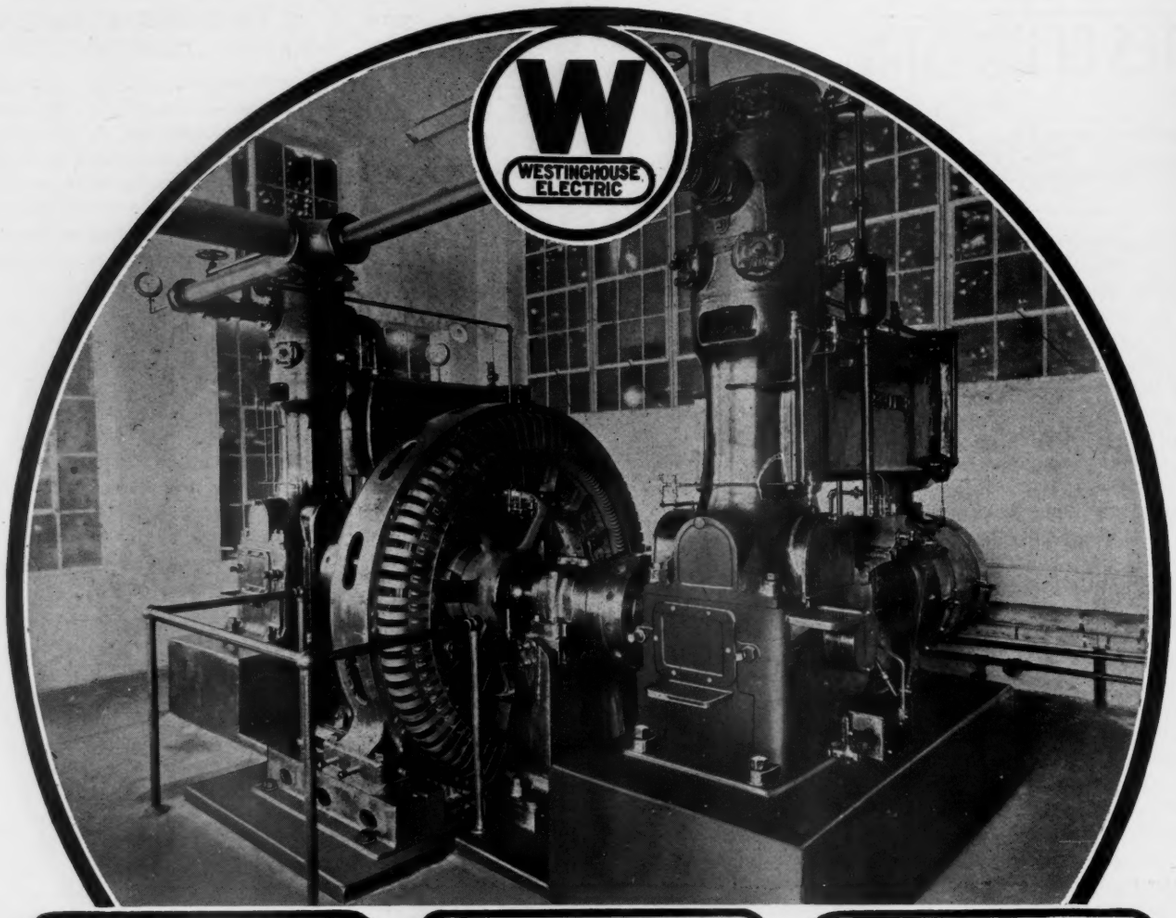
The new non-magnetic cast iron was produced in England, and is the result of experiments conducted by S. E. D. Dawson, chemist and foundry manager for Ferranti, Ltd., Manchester. According to *Iron and Coal Trades Review,* London, the metal, which is called "No-Mag," is an alloy with properties similar to those of brass or gun metal, but is much less expensive. It is especially valuable in electrical construction.

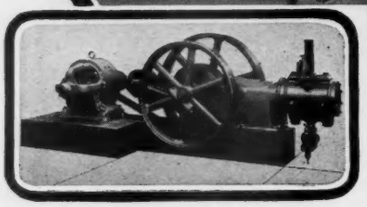
The iron can be cast with the same facility as ordinary cast iron, and has the same appearance. In strength it follows the usual figures for cast iron, but has the advantage of increased toughness and malleability.

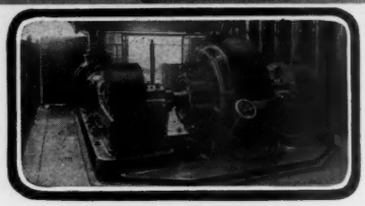
The cost of "No-Mag" is dependent upon the type of casting, and, roughly, may be taken to be 20 to 50 per cent. higher than that of gray iron. When the price is compared with that of gun metal the advantage is obvious.

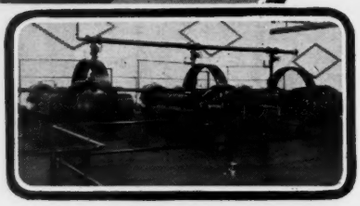
It is estimated that 46,963,000 gross tons of iron ore was mined in the United States in 1922, an increase of 60 per cent. compared with the quantity produced in 1921.

A new glass factory is to be established in Lima, Peru, which is to be operated under the management of an American expert. The necessary machinery is to be purchased in the United States.









IF YOU are in the market for compressor motors — make this test before you buy.

Go where motor driven compressors are used, and talk to the men who operate them. Inquire about the adaptability of motors to compressor drive. Ask about their dependability, construction, maintenance, efficiency, power consumption and service rendered under trying conditions.

Convince yourself from the unbiased information you will have gathered in the field.

We are confident that the reports on the performance of Westinghouse motors will have convinced you of their desirability for compressor drive.

Westinghouse Electric & Manufacturing Co.
East Pittsburgh, Pa.

Westinghouse

As a matter of reciprocal business courtesy help trace results